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CONTENTS.

	PAGE
Mosquitoes and Malaria. By Percy H. Grimshaw, F.E.S.	49
Two Months on the Guadalquiver.—II. The Marismas. By Harry F. Witherby, F.Z.S., M.B.O.U. (*Illustrated*)	51
The Fluctuations of Rainfall. By Alex. B. MacDowall, M.A. (*Illustrated*)	54
The Mycetozoa, and some Questions which they Suggest.—II. By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry.	56
Notices of Books	58
Books Received	60
Sunset on the Mare Crisium. By E. Walter Maunder, F.R.A.S. (*Illustrated and Plate*)	60
The Planet Eros (D Q, 433)	62
Letter: "Perplexed"	62
British Ornithological Notes. Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.	63
Science Notes	64
Electricity as an Exact Science.—II. Units and Measurements. By Howard B. Little	64
Triple Atmospheric Corona. By the Rev. Samuel Barber. (*Illustrated*)	67
Mammoth Ivory. By R. Lydekker	67
Microscopy. By John H. Cooke, F.L.S., F.G.S.	70
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.	70
The Face of the Sky for March. By A. Fowler, F.R.A.S.	71
Chess Column. By C. D. Locock, B.A.	71

MOSQUITOES AND MALARIA.

By Percy H. Grimshaw, F.E.S., *Natural History Department, Edinburgh Museum of Science and Art.*

FOR some time past mosquitoes have been accused of taking an important part in the dissemination of certain diseases. This accusation was justified some years ago by the researches of medical men into the nature of the disease produced by a parasitic worm known as the *filaria*, or thread-worm, various species of which are found beneath the human skin, and which are quite common in hot countries. The mosquitoes, in sucking the blood of an infected person, are supposed to imbibe the parasites into their own system, and then by dying, or in other ways, to contaminate water, which may be afterwards drunk by some other person, to whom the disease is thus communicated. Quite recently, however, successful attempts have been made to connect the "bite" of a mosquito directly with the production of various forms of malaria, or malarial fever, as it should more strictly be called. It seems that the medical experts in London are now accepting the conclusions of Prof. Grassi, of Rome, as to the cause of black-water fever, which is one of the worst forms of malarial fever, and the scientific staff of the Natural History Museum, at South Kensington, are inviting travellers in all countries to collect as many mosquitoes as possible in the districts visited by them, with a view to properly identifying the various species, and tracing out still further the supposed connection between these insects and some of the fevers prevalent in tropical climes.

In the transactions of the society known as the "Reale Accademia dei Lincei," published at Rome during the last three months of 1898, Profs. Grassi and Bignami have given a most interesting account of their experiments and conclusions. As their communications are in the Italian language, and not generally accessible, it may be useful to give here a short *résumé* of their researches. In order to thoroughly understand the subject, however, my readers must have a proper idea of the insects concerned, and also of the nature of their so-called "bite."

The name "mosquito" has from time to time been applied to almost any small insect which sucks blood, but, properly speaking, it only refers to members of one group or family of two-winged flies, that which contains the true gnats. The latter name can therefore be applied with absolute accuracy to mosquitoes. In this country we have about twenty different species of gnat, in Europe there are about fifty, and in the world generally over one hundred and fifty. No doubt, with the increased attention which will now be paid to this family of insects, many more species will be discovered, although most people will be of the opinion that we have a sufficient number already! As I cannot describe all the species without devoting a small volume to them, and as they are all closely related to one another in structure and habits, it must suffice to say a few words about the best-known species, that bearing the name of *Culex pipiens*. This is structurally a very beautiful insect, about half an inch in length, which announces its presence by the peculiar "piping" sound to which it owes the second part of its scientific name. It has only a single pair of wings, thus proclaiming itself a true dipterous or "two-winged" fly, six long, slender legs, a pair of feelers or antennæ, and a proboscis which does all the harm. The antennæ differ greatly in the two sexes, for while in the male they take the form of a pair of beautiful feathery plumes, in the female they consist of a simple series of joints each bearing a ring of short hairs. The sexes also differ materially in the structure of their mouth-parts, and it is important to note that only the female "bites" or rather "punctures." The male is quite harmless owing to the deficient nature of its mouth-organs, and it is only necessary therefore to describe the proboscis of the gentler (?) sex.

Briefly, the proboscis of the mosquito consists of a tube, or rather trough, within which are concealed no less than six bristle-like boring implements, two of which are somewhat broadened and sharpened at the tip to form a pair of small lancets, and other two barbed or serrated, so as to form most effective saws. When the insect begins its work it fastens the end of the trough firmly down against the flesh of its victim. Then it places the bristles close together so as to form a solid boring instrument, which it plunges into the flesh and then sucks up the blood through the tube which is formed by the union of the bristles with the trough.

Now, as mosquitoes are almost invariably found in damp or marshy places, it is not surprising to learn that the early stages of their life-history are aquatic. The female insect lays about a couple of hundred eggs in a tiny boat-shaped mass, which floats like a raft upon the surface of ponds and stagnant water of all kinds. The eggs soon hatch and produce grubs which live entirely in the water,

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moving actively about by means of a series of curious jerks, and occasionally coming to the surface to breathe. This grub, which, by the way, differs from its parents in possessing a pair of true biting jaws and no sucking apparatus, soon transforms itself into an odd-looking creature, which never takes food at all, for the reason that it has no mouth. When the time comes for a further change, the skin of this grotesque creature splits open along the back, and out steps the dainty little gnat or mosquito, which, after drying its wings, flies off, to commence (if it happens to be a female) its torturing attentions to man or beast.

As the name "malaria" (meaning "bad air") would seem to imply, one of the earliest ideas was that the disease originated by the inhalation of various noxious gases which are generated in swampy districts. Decaying vegetation was also supposed to be an active cause, as were also great and sudden changes of temperature. The connection of bacteria with the disease was first mooted about the middle of the century, and by later researches has been established without a doubt. The germ or bacillus of malaria was first discovered in 1879, at Rome, by two Italian investigators, and since that time their fellow-countrymen have kept well to the front in the study of this important subject. Although the bacterial nature of malarial fever in its various forms has been thus clearly established for some little time, the method of its dissemination remained a mystery until the startling discoveries due to Grassi, Bignami, and others.

According to Prof. Grassi, the first person to hint at the curious relations between mosquitoes and malaria was an investigator of the name of Laveran, who latterly, however, limited himself to the conception that infection took place through the air or water, at the same time admitting that the bacillus spent some part of its existence in a lower animal or vegetable. Next, Dr. Manson supposed that the germ was normally present in mosquitoes or in some other sucking insect, and that on the death of the latter it would commence a free life in the air or water, entering the human body by inhalation or by the drinking of water. Koch at first held a similar theory, but Bignami went a stage further, and conceived the idea of *inoculation* by the bite of the insect, which might be a gnat or some allied insect inhabiting damp places. Last year Koch confirmed the American researches, showing an analogy between the behaviour of ticks in the propagation of the disease in cattle known as Texas fever, and that of mosquitoes in relation to malarial fever, both these diseases being due to bacilli undoubtedly related to each other. Later still, both Manson and Ross have made some interesting communications, the researches of the latter having reference to germs in birds which also have a species of mosquito as intermediate host.

The first thing Grassi set himself to do, therefore, was to find out what species of insect must be considered guilty of spreading the disease. As he tersely remarks, only some species can be culpable, because there are districts notoriously teeming with mosquitoes and yet not infested with malaria, while on the other hand the times or seasons of these insects, and the appearance of the disease do not always coincide. By a process of elimination the Professor sifted out the species until only a few were left for further investigation as at any rate suspicious. Among the results which followed, the two here given are the most important: (1) *three* species of gnat or true mosquito must certainly be regarded with great suspicion, and (2) *Culex pipiens*, whose life-history we have briefly sketched above, must be considered harmless.

With regard to *Culex pipiens*, Grassi reports that this species is the predominating one in non-malarial districts, while, on the other hand, it is scarce, or even wanting altogether, in not a few districts infested with the fever. Further confirmation of its innocence is also found in the following case cited by the Professor, as observed at Follonica, in Tuscany. This region is much infested by malaria, and in the house which serves as hospital for the foundries there the ground floor is set apart for the patients, while the upper stories accommodate the medical staff. In August last, when Grassi visited the place, the only species found there was the one in question, and, in accordance with this fact, we learn that the physicians never had to record the development *de novo* of a single case of malaria. On the contrary, among the workmen of the foundry who live a little distance away, the cases of fever were in daily evidence. By searching in their houses certain of the suspected species were found, which evidently accounted for the presence of the disease.

Unfortunately, the various species of mosquito have no English names by which they can be distinguished. Therefore, in speaking of the three more particularly concerned in the question now before us, we shall be compelled to use their scientific names. These names are *Anopheles claviger*, *Culex penicillaris*, and *Culex malariæ*. Of these, the first, which we shall refer to simply as *Anopheles*, according to Grassi, is constantly found in all malarial districts, and is much more frequent where the disease rages more fiercely. It may be distinguished from its relatives by having its wings spotted, with the spots arranged so as to form a capital letter T. Grassi calls it a "spy" of malaria, and says that the relations between it and the disease have been confirmed in Lombardy, Tuscany, the Roman Campagna, and in many other places. After giving the details of many cases where the disease and the insect either co-exist or are both absent, he refers to a locality near Saronno, where in the middle of a healthy district is a small circumscribed area infested by malaria, and, curiously enough, the *Anopheles* is found there, but not in the surrounding healthy zone. A similar instance occurs near the small lake of Ceriano.

The rice-fields are veritable hot-beds of malaria, and mosquitoes are exceedingly abundant there, too. An exception in both respects occurs near Veniano, where there is a very small rice-field so deficient in regard to its water supply that the rice does not prosper. Grassi found no mosquitoes there, and the medical authorities, likewise, have failed to record the presence of disease in its neighbourhood.

Up to the time of writing the first of the three papers we are now summarizing, Grassi only found a single exception to the co-existence of *Anopheles* and malaria. Near Saronno there is an expanse of artificial swamp containing a few mosquitoes, but cases of disease have not as yet been reported. Considering, as Grassi says, that the swamp is artificial and relatively recent, it can be readily seen that the opportunities afforded to the insects of becoming infected have not been frequent, as owing to the peculiar situation of the swamp very few persons have been bitten.

The second species, which bears the name of *Culex penicillaris*, is also undoubtedly instrumental in spreading the disease, especially in September, when the *Anopheles* begin to diminish in numbers. This species is more frequent, too, in places troubled by September malaria.

The third species put down as guilty appears to Grassi to be a new one, and he, therefore, gives to it the very appropriate name of *Culex malariæ*.

As to the time of day when the insects bite, our author states that the *Anopheles* prefers to attack within an hour on either side of sunset. In about an hour and a half at

this time of day one may be bitten more than a hundred times, while throughout the rest of the day and night not five bites may be received. The second species bites more at twilight than at any other period of the day, as does also *Culex malariæ*. All these facts fit in exactly with the common knowledge that the twilight hour is the most dangerous one in malarial regions. Moreover, the three species in question, and especially the first, enter houses much more readily than others.

Another important fact is that the mosquitoes of malarial districts, especially the guilty ones, rarely ascend to a great altitude. Therefore, in houses, the rooms of the second and third flats are not visited much by these pests, and this fact agrees well with the well-known comparative salubrity of these higher rooms.

It must always be borne in mind that in order to produce fever in a healthy person by its bite the mosquito must itself have previously bitten someone already stricken with illness, and therefore of necessity only a small proportion of the insects can be dangerous, even in a badly-infested locality. The greater number of them bite domestic animals, such as oxen, horses, pigs, dogs, pigeons, fowls, etc., as well as man. One might, therefore, be bitten thousands of times without being inoculated with the bacillus, while, on the other hand, a single bite might be sufficient. These possibilities must be taken into consideration when we read of the failure of the early experiments to demonstrate the actual transference of the bacillus from the blood of the patient to the body of the insect. In a joint note published by the three investigators, Bastianelli, Bignami, and Grassi, they announce that they have been able to follow with certainty certain phases in the development of a bacillus in a portion of the alimentary tract of *Anopheles claviger*. The specimen examined had been made to suck the blood of patients suffering from malarial fever, and the different phases observed seem to correspond to some described by Ross in the case of a bacterial parasite in birds. In a room where four malarial patients lived, these authorities collected half a dozen *Culex pipiens*, four *Anopheles claviger*, and one of another species. The examination of all these insects proved without result, except in the case of two of the *Anopheles*, which yielded bacilli in the stages of development just alluded to. In an appendix to this communication, the same authors state that they have succeeded in producing one of the varieties of malarial fever in a patient solely through the effect of bites made by this same species. The man was certainly not previously suffering from malaria, and lived in a place certainly free from the disease. They have also obtained, within the alimentary tract of the insect, later stages in the development of the bacillus than those mentioned in the account of their previous experiments.

Grassi records it as his conviction that not only do mosquitoes convey the infection of malaria, but they are probably the *only* means by which the disease is spread. This is a bold statement, and the author of it answers one or two objections that might be raised against it. One is that cases of malaria sometimes develop in great numbers after a heavy shower of rain. Grassi points out that these may be merely relapses of the fever, and that also before these showers mosquitoes are particularly troublesome. Many cases of malaria were reported to the Professor on very high medical authority as having been developed in places free from the presence of mosquitoes. In all the cases he was able to investigate, however, there was unmistakable evidence that the attacks of such insects had intervened.

I might go on multiplying these remarkable relationships to some length further, but must now draw my abstract to a conclusion. In so doing I can only say with the Professor, who has furnished the facts and conclusions upon which these remarks have been based, that the investigation of malaria is entering upon a new phase, and we can now indulge a little more than formerly the hope of being able soon to battle successfully with malaria in all its forms. It would not be difficult to make any particular species of mosquito rare in a malarial district by a wholesale destruction of the grubs.

TWO MONTHS ON THE GUADALQUIVER.

By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

II.—THE MARISMAS.

THE small creek in which we were anchored proved a pleasant spot, at all events from our point of view. Birds were plentiful all around us, not only during the hot and glaring day, but also at night, when their notes—some well-known to us, some unknown, wild and weird—formed pleasing variations to the metallic buzz of the persistent mosquito.

This part of the *marismas* consists of dry caked mud, covered with short grass and dwarf bog plants. At intervals, even this scanty vegetation ceases altogether and mud and water reign supreme. These patches of water, some of which are very large, are called *lucias*. They are quite shallow, being seldom more than two feet in depth, and they are encircled by a belt of dry mud, the surface of which is pitted with hoof marks, and cracked in every conceivable direction. Being a luxurious feeding place for ducks, geese, and all wading birds, a *lucia* forms a perfect Eden for that eccentric being, the ornithologist.

To deal first with the dry land. Within a few yards of our camp were the nests of two different species of larks very common in this district. One, the calandra lark,* is a veritable giant amongst larks, being almost the size of a song thrush. We nearly walked upon this bird before she rose from her nest, and flew up with a tremendous flutter, tumbling in her flight, and running along the ground in front of us with trailing wings. The calandra has a bold, bright song, uttered when the bird is on the wing, and, like our skylark, it is given to imitating the notes of other birds. A few steps away from the calandra's nest we flushed a very small lark, which, unlike the calandra, rose quietly from her nest and disappeared. This was the Andalusian short-toed lark,† discovered by Lord Lilford in 1872, and first described by Mr. H. E. Dresser in his "Birds of Europe." These little larks, which are very numerous in the *marismas*, seem to be peculiar to this part of the world. They do not soar like the calandra and the skylark, but take short, upward flights, singing as they go, and, returning to the ground or a low bush, finish twittering there. We heard them imitate the notes of many birds—such as stilts and redshanks. By the 8th of April their nests were numerous. Those we found were invariably built of dry grass and fine roots, lined with a few feathers, and placed in a slight hollow in the ground, often hidden by a tuft of grass or a small bush. The only other diminutive bird that was at all common in this scorched-up wilderness was a beautiful blue and yellow wagtail—the blue headed wagtail.‡

Many peewits§ had their eggs or young amongst the grass, and the efforts of the parents to drive off the birds of prey afforded us constant amusement. They devoted their

* *Melanocorypha calandra.* † *Calandrella bætica.*
‡ *Motacilla flava.* § *Vanellus vulgaris.*

energies chiefly to the kites. A kite comes swooping majestically along as though he were altogether too fine a bird to notice anything smaller than an eagle. Suddenly two peewits rise from the ground and dash straight at that kite. He swoops on as though he had noticed nothing. But the screeching peewits whirl round again and attack him hotly from above and below. Watch him carefully and you will see him flinch and swerve, as time after time the brave little birds dash into his face. When one pair of peewits has seen him safely off their preserves, another pair flies up and attacks him, and thus he is "escorted" across the *marismas*. A pair of peewits is quite a match for a kite. I have seen one forced to drop his meal—a piece of offal—and fly away hungry because he happened to be too near some peewits and their family. Strange to say, the peewits do not attack the harriers so vigorously and persistently, although they are even more numerous than the kites, and perhaps as great egg and chick eaters. In fact, I feel sure that a harrier has a far more profitable journey across the *marismas* than a kite; but he goes about his business in a quiet, unostentatious way, flying low and quartering the ground in a systematic manner, as though he were more of an entomologist than an ornithologist.

We had often wished to become intimately acquainted with the stone curlew,* sometimes called the thicknee or

Fig. 1.—Our Camp.

Norfolk plover, a bird which is to be seen in England only in certain localities. Our wish was gratified on these dry plains, where the bird was common. To a great extent it is a bird of the night, and it was at night, when their stirring notes broke the stillness round the camp, that we began our acquaintance with them.

The usual note of the stone curlew is a loud harsh cur-er-ree. One night, when sitting round our lamp skinning and writing, in the midst of an angry crowd of mosquitoes which one of our men was vainly endeavouring to keep moving with a towel, a stone curlew gave us an extraordinary solo. He appeared to be composing a song. Beginning by rapidly repeating his usual note very softly and in a very low key, he suddenly went up to a very high key, then down again, and so on for quite ten minutes. It was like a human singer going from bass to falsetto, but the bird accomplished it perfectly, without a break, and apparently without an effort.

* *Œdicnemus scolopax.*

In the day these birds are usually silent and in hiding, but they are not to be caught napping. They always seemed to see us before we saw them, which was not to be wondered at, since with their sandy brown plumage they were very inconspicuous, while we were plainly visible at quite three miles distance. Consequently we found it difficult to cultivate the acquaintance of the stone curlew. For the first few days, when one rose, as they generally do, about one hundred yards off, we rushed towards the spot knowing that its mate, having run from the eggs in alarm, would soon take to flight. But we were always outmanœuvred; the bird ran as fast as we did, rose suddenly at an impossible distance, and soon joined the other bird a mile or two away. We had more success by waiting quietly behind our stalking horses when the birds rose. Not being so alarmed they did not fly far, and several times we marked them down and stalked them successfully. Often, however, they were suspicious even of the *cabestro* and ran away from it like greyhounds. Only twice did we surprise these birds. On each occasion the bird immediately lay at full length, with head extended flat upon the ground, and when we had approached to within about twenty yards, it leapt suddenly into the air and was off and away before we recovered from our surprise. We found several pairs of their beautifully-marked eggs lying side by side in the merest scoop on the hard ground. In the more fertile country we came across the eggs among the sand, closed in on all sides by high tamarisk bushes—a curious place to be chosen by a bird which is a lover of the open country.

We were riding home one evening, tired and fly-bitten, across a sun-burnt plain, when we saw an Egyptian vulture give chase to a stone curlew, which we had frightened into flight. The curlew was evidently not at ease. It began by flying low and straight, then it dodged and turned and flew round and up, calling plaintively all the while. The ungainly vulture flew doggedly and silently after it, keeping well up in the straight flying, but getting sadly behind whenever it tried to follow the curlew's sudden twists and turns. We watched this curious chase until the birds were mere specks many miles away, and we wondered much if the vulture had a private spite against that stone curlew, or if it merely needed exercise after some unwholesome gorge.

Never shall we forget our first day in a *lucia*. From afar we had seen the water—a great glistening expanse, unbroken save for a group of cattle away on the left, and straight before us a straggling bed of tall greyish reeds. As we got nearer, the reeds gradually took the shape of birds, until at length a long line of flamingoes* was revealed standing in knee-deep water. They looked a dazzling white in the brilliant sunshine. Round them were hundreds of dark dots, ducks of various kinds, and a little way off a small group of white clumsy-looking birds, which we made out with glasses to be spoonbills.† Nearer to us, in shallower water, black and white avocets‡ and long-legged stilts§ were feeding, while round the margins of the water, dabbling in the soft mud, were hundreds of small wading birds of various kinds.

We determined to devote ourselves first to the flamingoes, and try to stalk these wary birds. Our men put their *cabestros* in stalking trim, and we started to crouch behind them when about two miles away from the birds. Before we reached the water we came across a group of fifty or sixty mounds of mud some eight or ten inches high. These were old nests of the flamingoes, and our men told us

* *Phœnicopterus roseus.* † *Platalea leucorodia.*
‡ *Recurvirostra avocetta.* § *Himantopus candidus.*

that the birds had laid there the year before, when water was plentiful, but that in this dry season the nests were half a mile away from the edge of the *lucia*. When we visited this place again at the end of May, the *lucia* had almost completely dried up, and it is extremely unlikely that the flamingoes nested that year in Spain. Even in the wettest seasons, although the flamingoes build nests and lay eggs, they never seem to hatch out young in Spain. We left the nests with some regrets that we had happened upon a dry season, and soon arrived at the edge of the *lucia*. Now we found that our stalk would not be an easy one, as there were many birds of different kinds between us and the flamingoes. If we went straight on we should disturb these birds, and they would disturb the flamingoes, so we had to make a big detour. With infinite trouble we worked to within one hundred yards of the birds in about an hour, but we had frightened several flocks of smaller

Fig. 2.—Flamingoes. (From a photograph by Mr. D. Le Souëf. By kind permission.)

birds on our way, and when we peeped at the flamingoes from under the horses, we saw that their suspicions had been aroused, and that they were walking rapidly away from us. However, we persevered, and followed them, but they would not allow us to come nearer, and away "like a blood-red flag the bright flamingoes flew."

We had not finished with these flamingoes. Our backs were aching dreadfully, owing to want of practice in walking, bent double, behind small horses. So when our men pointed out that the flamingoes had settled in another *lucia*, and were admirably placed for a drive, it was not for us to deny it. Accordingly, we kept behind the horses until we reached the dry land, and then we crawled some distance to a spot of land which divided the water we had left from the water in which the flamingoes now were. Here we lay down, scarcely concealed by the scanty herbage. About a quarter of a mile in front of us were the birds. We calculated the flock at about five hundred strong—a small flock compared to others we saw afterwards. Our "beaters" had to go a long way to get round the flock, so we had plenty of time to watch the birds with our glasses. Some were standing on one long pink leg—dozing with head and neck tucked away in the feathers of the back; others were striding about slowly and majestically; while others with necks bent and heads inverted, were "sifting" the water with their bills in search of food. They looked a happy party, but were soon to be disturbed by the ruthless arts of man. Suddenly the long necks went up in alarm, and then the bright white phalanx began to show pink here and there as a bird raised its brilliant wings; then followed a great blaze of pink, and with a deep-toned "gonk" from every throat the whole flock slowly rose. As the birds spread out, the rich crimson of their wings eclipsed everything, and a brilliant sunset seemed to flash across the sky. We gazed at them for a moment and then ducked our heads and lay pressed to the ground like a couple of stone curlews. So well had our men driven, that the whole gaggling crowd headed straight for us, with necks and legs outstretched as they flew. Not until they were right over our heads did we jump up. Above us was a bewildering mass of flapping wings—pink and black, and white necks and pink legs—stiff and straight. Four bangs in quick succession, and four flamingoes dropped their heads and legs, crumpled up, and fell spread-eagled on the mud. The Spaniards galloping up laughed loudly at two mad Englishmen leaping wildly round some dead flamingoes.

We were much fascinated by the flamingoes, and had many other opportunities of interviewing them. One day we spent several hours in photographing a small flock. The results were unfortunately not successful, although we had the good fortune, by reason of every condition

being in our favour, to approach within forty yards of the birds.

Our encampment was in the direct line of the evening flight of many birds from one stretch of water to another. Every evening, just at sunset, we sallied forth to sit and wait, in danger of being eaten alive by mosquitoes, for the flight. For ten minutes or so no bird was to be seen or heard. Then in the far distance a great flock of birds appeared silhouetted against the glow of the setting sun. For a quarter of an hour these shadows flew up and down, tailing out and bunching up, performing all sorts of

Fig. 3.—The Dead Flamingo.

evolutions, and forming all manner of shapes and patterns like a flock of knot or dunlin in an English harbour. At last they steadied down and flew towards us, looking larger and larger until we were astonished to find that these practised performers were flamingoes, which we knew to be accomplished runners and walkers, but had hitherto regarded as clumsy flyers.

No better way could be devised for observing shy birds than from behind the stalking horse, and many were the hours we spent thus with our field-glasses to our eyes.

We often approached to within a few yards of avocets and watched their curious method of feeding. The bills of these birds are flat like a piece of whalebone, and are curved upwards. The birds stand in shallow water, and instead of probing the mud as other waders, they sway their heads to and fro, and with their upturned bills scoop from the mud or water the insects and worms upon which they feed.

Many waders which are common on our English coasts in autumn were here in thousands. Most of them had, no doubt, wintered still further south, and were now but breaking the journey to their breeding places—the moors and tundras of the far north. Grey plover,* with white foreheads and black breasts—their beautiful summer dress—were everywhere in small flocks and in big flocks, from April 27th until we left on May 19th. Wild as the grey plover is in England, we found him wilder here, and, next only to the flamingo, he proved the most difficult bird to stalk.

The smaller waders we had no difficulty in approaching, and we often guided our horses right into the midst of a flock before the birds realised that dreaded man was behind the horse. These flocks were composed of many species of birds. To describe one such flock, let me take a page from my notebook written on the spot.

A dunlin,* so near me that I could have touched it with my gun, was tugging vigorously at a monstrous worm which refused to be "drawn," and by his brother's side was another dunlin, looking on with interest and anxiety. Just near them were a number of their miniature cousins the little stints,† while a little further off were curlew sandpipers,‡ with the rich red breasts of their summer plumage, and to and fro, and in and out amongst them, ran those active little birds the ringed plover§ and the Kentish plover.‖ We moved on slightly to examine the rest of the birds, when with a sudden gasp a dunlin spied us and the whole flock flew off. Just at that moment we heard a swish of wings, and a peregrine¶ swept past us. In another moment he had caught up our little friends, and singling one out dashed straight at it, and seized it in his powerful grip. The falcon appeared to take no notice of us, but sailed round and settled upon the dry mud half a mile away. While one of us went off to stalk, the other waited and watched. It was a fine sight to see the noble bird standing on his prey and tearing at it, but presently he left his quarry and rose into the air, only to fall back upon the mud dead. We gazed upon them—slayer and slain—the one a perfect male peregrine, with his barred breast, glorious blue-grey back, and the other a poor little Kentish plover, already torn and headless.

* *Squatarola helvetica.*

THE FLUCTUATIONS OF RAINFALL.

By Alex. B. MacDowall, M.A.

BACON remarks, in his "History of the Winds," "It has been observed by the diligence of some, that the greater and more remarkable seasons of the weather, as great heats, great snows, great frosts, warm winters, and cold summers, generally come round in a circuit of thirty-five years." Again, in his essay, "Of Vicissitude of Things," "They say it is observed in the Low Countries (I know not in what part) that every five-and-thirty years the same kind and suit of weathers come about again, as great frosts, great wet, great droughts, warm winters, summers with little heat, and the like; and they call it the *Prime*."

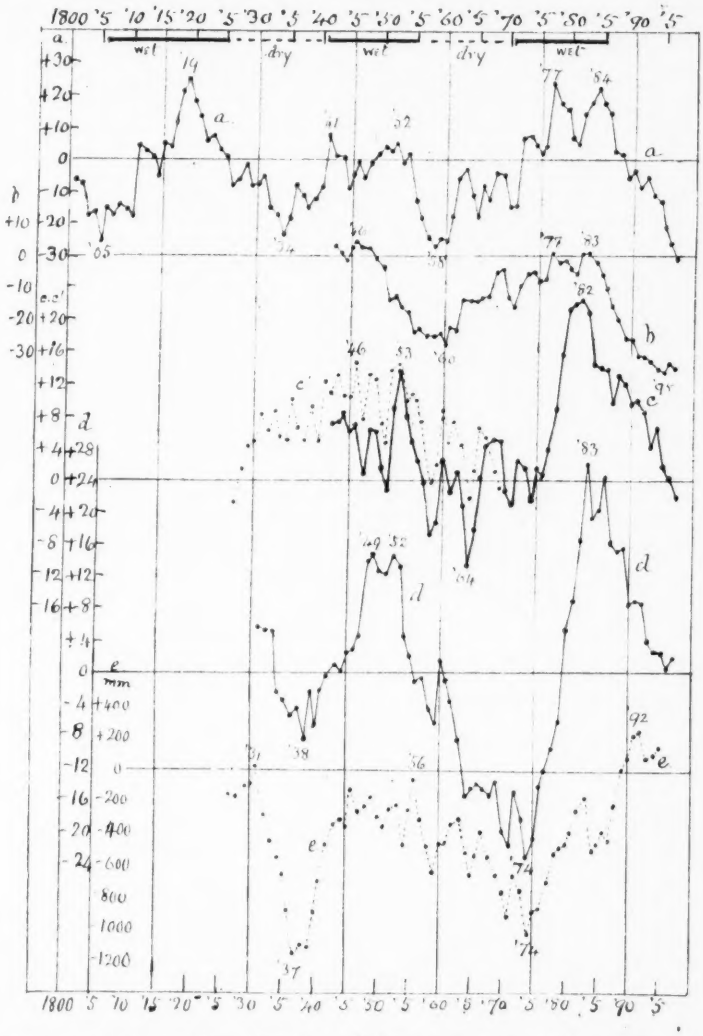
These passages have a special interest in relation to the remarkable work of Brückner, published some eight years ago. From a wide survey of weather changes, it is known, he concludes, that since 1700 at least, most of the land surface of the earth has been subject to a recurrence of cold and wet periods, alternating with warm and dry ones, and that the (varying) interval from the middle of one period to that of the next of the same kind is, on an average, about thirty-five years. Speaking generally, the wet periods in this century are 1806-25, 1841-55, and 1871-85, and the intervening ones have been dry. (The cold and warm periods tend to precede the wet and dry a little.) Putting the case otherwise, the years 1815, 1850, 1880, are given as approximately centres of cold and wet periods, and 1830 and 1860 of warm and dry ones. There are a few exceptions to the rule. For example, in Ireland, and islands in the North Atlantic, the variation is of an opposite character. Brückner considers that compensation occurs, not on land, but on the sea.

In Knowledge last year (June number) were given some weather-curves of a special type; they were obtained

* *Tringa alpina.* † *Tringa minuta.* ‡ *Tringa subarquata.*
§ *Aegialitis hiaticula.* ‖ *Aegialitis cantiana.*
¶ *Falco peregrinus.*

through algebraic addition, step by step, of a series of plus and minus values of temperature, or rainfall, representing the relation of actual values to an average. Each rise in such a curve, from one point to the next, indicates a plus value, and each fall a minus value; while the position reached by the curve at a given date shows the then state of the weather account, so to speak; it might be compared to the balance at a bank after a number of transactions in which money has been, now deposited, now withdrawn.

It is instructive, I think, to compare together a number of rainfall curves of this character, made out for different



places, and to consider them in relation to Brückner's cycle.

In the diagram, accordingly, will be found such curves for Rothesay and Culloden, in Scotland (*a* and *b*), London (*c* Greenwich, *c'* Chiswick), Boston, in Lincolnshire (*d*), and Geneva (*e*).*

In all of these may be noticed long waves of variation, and the crests and hollows, the maxima and minima, may be taken as convenient and natural points of division.

Let us consider a pronounced curve like that of Boston, and ask what it means. It may be roughly interpreted thus:—From 1838 to 1849, a wet time, more wet years than dry; 1850 to 1874, a dry time, more dry years than wet; 1875 to 1883, a wet time, all the nine years wet; from 1884 to 1897, another dry time, still going on probably. The relation of dry to wet years in each slope can be easily ascertained by counting. We have here considered the year as merely wet or dry, but the degree of wetness or dryness should properly be also taken into account.

The intervals between maxima and between minima, in most of these curves, will be found to approximate closely to thirty-five years. Scotland, and the West of England, are considered by Brückner "temporary" exceptions; they sometimes conform to the rule, and sometimes not. In "permanent" exceptions the variation is opposite to the normal.

The detail of these curves need not be here dwelt on. We might note a tendency to retardation in the wave phases in lower members of the series as compared with higher.

The London curves, and the prospect they perhaps open up, may be shortly discussed. The Greenwich curve (1841-97) shows a minimum in 1864 and a maximum in 1882. The indications of the dotted curve (for Chiswick, 1826-69), must be reckoned inferior in value to those of the Greenwich curve; but if we may take 1846 as the culminating point of a long curve, we have the following relations:—A dry time from 1847 to 1864 (eighteen years); a wet time, 1865 to 1882 (eighteen years); and the dry time from 1883, still going on. How long will this last continue? Another eighteen years from 1883 would bring us to the end of the century. The curve should soon be turning up again; and we may fairly expect to enter soon on another wet period, ending, say, about 1918.

The periods indicated by those curves do not coincide *exactly* with those of Brückner (top of diagram); nor should we expect them to do so. The limits assigned are not rigid for all places.

The old question comes up: Has the sunspot cycle of eleven years anything to do with our rainfall? It is hard to trace any such influence in these curves; but that is not, of course, sufficient to close the subject. There are other points of view, and from some of these, certain curious and interesting relations may be perceived.

Thus, instead of considering how much rain falls in a year, and the relation of this to the average, let us ask, How many wet months occur in a year (calling a month wet where its rain is over the average for that month)? There are fewer wet months than dry; the yearly average is nearer five than six.

Now, in the sunspot cycle, we have a short period of increase of spots (say four years on an average), and a longer period of decrease (say seven years); and if we compare different year-groups in the cycle in respect of the number of wet months they contain, we meet with

* The vertical scale, it will be seen, is varied. In giving a curve for Greenwich, I gladly take the opportunity of correcting an inaccuracy in that formerly given.

certain rather persistent contrasts. Thus, comparing the periods of increase of spots with those of decrease, there seems to be a tendency to more wet (more wet months) in the latter.

An instructive comparison, I think, is that of the five years just after minima with the five years ending with minima—*i.e.*, (roughly) the period of growth of the spots with the latter part of the period of decline.

Consider this table :—

Five Years after Minima.	Wet Months.	Difference from Average (27).
1824–1828	24	−3
1834–1838	26	−1
1844–1848	25	−2
1857–1861	27	0
1868–1872	25	−2
1880–1884	22	−5
1891–1895	25	−2
		−14

Five Years ending Minima.	Wet Months.	Difference from Average (27).
1819–1823	33	+6
1829–1833	35	+8
1839–1843	29	+2
1852–1856	27	0
1863–1867	31	+4
1875–1879	30	+3
1886–1890	23	−4
		+19

Thus one group apparently tends to be dry and the other to be wet. The one exception (1886–1890), with preponderance of dry months in the second group, occurs, we may remark, in one of Brückner's dry periods.

Should this state of things appear to any merely fortuitous, they might, perhaps, further see reason for an adverse view in the fact that the relation indicated certainly does not hold good everywhere.

Are we not, however, beginning to see that sunspot influence on weather, if probably real, is probably, also complex in character, and that the rough generalizations, hitherto considered applicable to it, may be found to need revision ?

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—II.

By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry.

Nuclei.—In the history of the theory of cells it was early discovered that there is in each cell a smaller structure called the nucleus, which was originally supposed to be a vesicle in the cell, but has been now ascertained to be a portion of a special substance distinct from protoplasm. The nucleus has been found to exercise something like a dominant influence on the destiny of the cell—"all the formative and nutritive processes seem to be dependent upon it," and, moreover, it plays an important part in each process of cell division—*i.e.*, in some or all cases of the division of the cell the nucleus undergoes a like division. This division occurs in three ways, of which two only need now be noticed. One of these modes of division is very simple. The nucleus gets constricted in the middle, the connecting link grows slighter and slighter, and breaks, and we have two nuclei where before we had one. The other method by which nuclei divide is a highly complicated and remarkable process, known often by the long name of Karyokinesis—*i.e.*, the movement of the kernel. In this process certain polar bodies appear, round which the constituents of the cell gather, and the nucleus assumes a curious spindle-like shape before the division actually occurs.

Now, in the myxies, we have, as we know, no true cells with cell walls, except, perhaps, in the spores themselves, but we have protoplasts, in the form of swarm spores, provided with nuclei, as shown in Fig. 3. In the plasmodium, too, we have nuclei, and it has been supposed that the original number of nuclei in the plasmodium corresponded with the number of the constituent protoplasts, but it has been shown that the nuclei increase vastly in number, and that this division and multiplication of nuclei takes place in all the stages of the swarm cells, of the plasmodium and of the sporangium. The question whether this multiplication of nuclei in the myxies at the various stages takes place by simple division or by the complicated process of Karyokinesis is one which has been carefully investigated, although the results can hardly as yet be considered as conclusive. They appear to be, first, that Karyokinesis is the method pursued in the swarm spores when they divide, and again at a later stage in the sporangium shortly before the formation of spores; and, secondly, that the multiplication of nuclei in the plasmodium is sometimes accomplished by Karyokinesis, but probably, also, by direct division.

Powers of Protoplasm.—What are the powers with which the simple naked protoplasm of the Myxomycetes is found to be endowed ? It is endowed with—

(*a*) The power of motion ;
(*b*) The power of seizing and digesting food ;
(*c*) A capacity for excreting what is not suited for retention by the organism ;
(*d*) A capacity to perform chemical work ;
(*e*) A capacity to assume and change colour ;
(*f*) The power of attracting and being attracted by and uniting with other protoplasm of the same species ;
(*g*) A converse power of avoiding the protoplasm of other species ;
(*h*) A power to assume a definite external shape, and to divide into spores and non-spores ;
(*i*) A capacity to enter into a state of suspended vitality.

"Life never can arise out of or depend on organization," wrote John Hunter; and unless naked protoplasm be regarded as organized, his remark seems to be verified and proved past dispute.

Let us consider some of these faculties more in detail.

Motion.—The motions exhibited by the protoplasm of myxies are of the most varied kind. We have already mentioned the jumping motion of the swarm spores and the crawling action of the plasmodium : now we will ask our readers to turn again to Fig. 4, and to allow us to describe what is seen in a crawling plasmodium under a microscope.

The plasmodium is differentiated into two parts : the larger and interior part contains minute oil granules, or *microsomata* ; the external layer is free from granules, and is perfectly transparent like glass or water. The darker and granular interior protoplasm is known as the *endoplasm* ; the hyaline superficial layer is known as the *ectoplasm*. Fig. 4 is on too small a scale to exhibit this difference distinctly.

There are two motions here to be observed, though they are not disconnected with one another : first, the pulsating

motion of currents of protoplasm; and, secondly, the advance of the entire mass of protoplasm.

Under a microscope currents are seen to be established in the endoplasm, generally up or down the lines of advance of the plasmodium; the letters *st* in Fig. 4 indicate some of these currents. The granules stream in one direction; then pause, from sixty to ninety seconds (in the case of healthy plasmodia); then the current turns and streams in the opposite direction. These streams sometimes unite and sometimes divide. It is familiar that protoplasm when enclosed in cells often exhibits movements, as in the well-known case of the *Chara*, but then the movements are naturally constrained by the cell walls; in the free protoplasm of the myxies no such restraint exists.

If the peripheral edge of an advancing plasmodium be examined, there will be found in advance of the granular endoplasm a strip of the colourless and perfectly transparent ectoplasm, of which we have already spoken; it runs like the foreshore along the coast of the body. Into this from time to time a granule will be seen to advance, and then another granule, and so on till the line of the land has been pushed out into the foreshore, and the foreshore itself is moved forward into the sea. In this way the front line of the whole plasmodium advances, and as the rear of the plasmodium is drawn back in the line of advance as the front line is pushed forward, the whole body of the plasmodium gradually changes its place and moves forward.

It is a very striking thing to watch these forward movements of the granules. You seem to see in a minute and most intimate form the locomotion of living things; and, moreover, you perceive an internal movement of part, resulting in a movement in space of the whole organism. Mr. Spencer has said that "we have as yet no clue to the mode in which molecular movement is transformed into the movement of masses in animals." Does not the motion which we have described offer, if not a clue, yet a visible example of such transformation? Be this as it may, the mystery of motion remains just the same; there is the same antinomy between sense and reason—the one says that there is motion, the other that it is impossible.

"Io dirò cosa incredibile e vera."

It must not be supposed that it is only on the surface of dead wood or leaves that the plasmodia of myxies move. Sometimes, and especially under the influence of cold, they retreat downwards, and the *Fuligo*, a species which lives on tan and is known as the flowers of tan, will, under this influence, disappear from the surface of a heap and retire to the bottom of it. Cold or other unsuitable conditions seem to cause them sometimes to retreat into the wood to appear again under more favourable circumstances. Some plasmodia inhabit the interior of dead wood, and only appear on the surface for the purpose of fruiting: in the search for a suitable home for reproduction it has been thought that they move away from damper to drier spots, and they certainly often produce their sporangia in the dry air and in high positions. It has been thought also that light has a tendency to make the plasmodia ascend and darkness to descend. Sometimes a plasmodium will ascend a tree or a post for a foot or more, and a species known as *Lycogala epidendron* is said always to affect the highest point of the substance on which it rests. It is by no means infrequent for plasmodia to leave the dead wood on which they have been living and to ascend the stalks of flowering plants, or to spread over mosses, and often we have been surprised at the distances travelled by plasmodia in a few hours. The appearance, we may remark in passing, presented by the sporangia of delicate myxies on the leaves of mosses or blades of grass is sometimes very beautiful.

Plasmodia, as we have said, sometimes move in an upward, sometimes in a downward direction; in a seed, as we know, these two tendencies are separated, and the radicle tends to grow in the direction of gravity, and the plumule against it; in the myxies it would seem as if the same protoplasm at one time had the one tendency, and at another time the other. Perhaps, in passing, we may observe that the fact that plants and trees for the most part grow upward—*i.e.*, against the force of gravity—is one worth a good deal of thinking about, and when we look at the mass of fluid and solid matter raised every year, especially in the springtime, against the constant operation of the force of gravity, we get a notion of the magnitude of a force exerted by plants, to which we can assign no other origin than life, and give no other name than that of a living force.

It has been found with regard to the plasmodium of the flowers of tan that it has a curious tendency to move against the flow of water; thus, if one end of a piece of filter paper be placed in a vessel filled with water and the other on the table, so that the water flows downward, the *Fuligo* will move up the paper, and if the paper be so arranged that the water shall move up the paper, the *Fuligo* will move down.

Some observers believe that the myxie takes only such food as comes in its way; Mr. Lister believes that it uses its vibrating cilia to detect food; whilst others think they have observed that food exercises an attraction on plasmodia and influences their movements; thus, to return to the flowers of tan, a piece of tan or of wood steeped in tan has been seen, according to some observations, to induce the plasmodium to draw itself towards it, and that without reference to its position as regards the force of gravity. There seems no reason to doubt the accuracy of these observations. Here, then, we see in the primitive form of naked protoplasm that search after food which exercises so enormous an influence on the whole animal and vegetable world as well as in the social affairs of man. How, one cannot help asking, is the plasmodium made aware of the proximity of its appropriate food? Has it some rudimentary perception—some common sense, of which sight, and smell, and taste are only more specialized forms? What the plasmodium does in the equally near presence of two equally attractive morsels we do not know; but we do not believe that it would starve.

Sunshine is, again, a condition which seems to exert an influence on the movements of plasmodia. If a glass, on which the network of a plasmodium is spread, be partly exposed to the sunlight, it has been observed to withdraw to the shaded parts, and yet when the time comes for the sporangia to be produced it would seem in some species as if there was a movement towards surfaces exposed to light. But, according to the observations of Mr. Lister, light apart from direct sunshine does not affect the movements of plasmodia.

The plasmodium has been found to be sensitive not only to sunlight, to dampness and dryness, to heat and cold, but to the influence of chemical substances: the weak solutions of some chemicals having been observed to render it more fluid, whilst stronger solutions of the same substances have made it contract or perish in parts. This sensitiveness on the part of the plasmodia to so many influences must, it would appear, render very delicate the conditions under which alone myxies can succeed in the struggle for existence. Furthermore, it would appear that in the selection of places for the production of the sporangia they have to select situations affording enough atmospheric exposure to ripen the spores, and enough moisture to enable the swarm spores to swim and move about, and it is no

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doubt due to the width of the dispersal of the spores that they find these situations, which are, one would suppose, comparatively few. It is probably from this delicacy of the requisite conditions for success that plasmodia are not unfrequently seen to fail in the struggle of life. They will sometimes reach the surface, and commence the formation of the sporangium walls and spores, and then fog off and decay, without ever reaching maturity or producing sound spores.

The observations with regard to the influence of heat, drought, light, and darkness, on plasmodia may be correct, but it does not follow from them that the needs of the organism dependent on the stage it has reached, or on other circumstances unknown to us, may not also operate on their motions. We know that the sporangia are produced on the surface, but we hardly know whether the organism seeks the surface when it is time to develop sporangia, or develops sporangia when it reaches the surface.

Negative Geotropism.—It is not only in the motion of the plasmodium as a whole, but in the motion of its parts when it develops sporangia, that we observe an upward movement. Sometimes, no doubt, the sporangia are developed on the under surface or the side of the wood on which they grow. We are inclined to think that different species prefer different situations for the production of their sporangia, and that no one law is applicable to them all; but in all cases the sporangia appear to stand vertically to the plane on which they grow.

If we examine the trunk of an oak, we find an elaborate structure of hard parts which maintains the tree in its upward growth, and by the force of cohesion resists and overcomes the force of gravity drawing it downwards. If we examine the stalk of even a delicate flowering plant, we find that it is constituted of cells, and that the cell walls, as well as the fibres, afford to the stem a certain amount of support; but in the naked protoplasm of the myxie we have no woody tissue, no cell wall, and yet this, too, lifts itself away from the earth and towards the sun and the air. We then see that the upward motion of plants does not depend on cell walls, but is an inherent, an original capacity of some protoplasm.

We can easily appreciate the advantage which this upward tendency gains for the organism, for it lifts it into the air and exposes it to the influence of light. We know the great results on the surface of the earth of this so-called negative geotropism. If all plants had crawled along the ground like the thallus of Marchantia or the hyphœ of some fungi, we should have had a keener competition for surface space even than now exists, and we should have lost the beauty with which the earth's surface is clothed. In the myxie lifting up its sporangia, we can see in the small and in its simplest and most primitive form, the existence of the same power which enables the sequoia or the eucalyptus to lift themselves to such enormous heights above the ground. But of this power, this impulse, this faculty, this gift of resisting the force of gravity, and the attraction of the earth—what shall we say? what account can we give? We can only keep silence.

Capturing Food.—The habits of swarm spores in the pursuit or capture of their food have been very successfully observed by Mr. Lister. In the case of *Perichæna corticalis* he observed a swarm spore with four vacuoles, each stuffed with from six to eight bacilli; and in the course of twelve minutes he saw four bacilli drawn in by the projecting parts, or *pseudopodia* of the swarm spore. In the case of *Didymium* (or *Chondrioderma*) *difforme*, he observed that the capture of a bacillus is sometimes effected by pseudopodia. More often, a funnel-shaped aperture was formed in the posterior part of the swarm spore, and when a bacillus was unwary enough to enter, it was enclosed by a folding over of the lips of the funnel. The bacilli thus captured were seen to dissolve in the vacuoles, but no refuse matter was observed to be rejected; probably the whole bacillus was of absolutely digestible matter. On another occasion, Mr. Lister observed a swarm spore come upon a group of motionless bacilli. It spread itself out so as to cover four of them, and in about two minutes resumed its former shape, and crept away, carrying two bacilli in its vacuole. In the case of *Stemonitis fusca*, he observed the capture by pseudopodia of a bacillus so large that when drawn up into the body of the swarm spore it forced the swarm spore to bulge out on either side. On this followed a violent jerking motion of the swarm spore, which frequently occurs after the ingestion of food, and in a few minutes the bacillus was bent double, and the vacuole decreased in size. These observations of Mr. Lister seem to prove that the view of De Bary that the swarm spores take in nutriment only in a fluid state cannot be upheld. These processes are depicted in Fig. 3, which is reproduced by the permission of the Council of the Linnean Society and of Mr. Lister.

It is a curious fact that where a plasmodium on its march meets with a microcyst of its own kind, it has been observed to commit an act of cannibalism—to treat it as if a foreign body, and to enclose it in a vacuole, and then absorb it. Probably the presence of the membrane prevented fusion until it was removed by an act of digestion.

Rejection of Matter.—Mr. Lister has been equally successful in observing the method pursued by the plasmodium in the rejection of undigested matter. He fed, and I am afraid overfed, the plasmodia of *Badhamia utricularis* on thin slices of fungus, and when a plasmodium had become loaded with food material, many of the large vacuoles became charged with undigested matter, which assumed the appearance of a dark ball, and he "repeatedly saw these vacuoles push out as bubbles to the surface of the plasmodium and burst, discharging a cloud of refuse, consisting of fragments of starch and broken fungus hyphœ, into the water." But when the plasmodium creeps over glass, he observed the rejected matter, with a certain amount of plasmodium substance, to be left "on each side of the retreating veins, leaving a mass of the network after the plasmodium has withdrawn."

In other cases rejected matter, particles of starch or spores of algæ, or other things which have been taken up by the plasmodium, are found thrown aside in the hollow cavity of the foot of the sporangium, or even amongst the contents of the sporangium itself.

Notices of Books.

Practical Inorganic Chemistry for Advanced Students. By Chapman Jones, F.I.C., F.C.S. (Macmillan.) Illustrated. 2s. 6d. Written to meet the requirements of the new syllabus of the Science and Art Department, Mr. Jones's little book traverses the same ground as scores of others, with, of course, slight changes interpolated here and there to satisfy altered conditions. It is understood that a preliminary course of practical chemistry has been followed, and the student thus initiated into the mysteries of chemical manipulation can face the exercises here presented without much difficulty The course is nicely graduated, commencing with the preparation of some of the non-metals and their compounds (a pleasing feature of which is that these are resolved into classes), preparation of gases by the use of cold liquids, hot liquids, or by heating dry subtances, and so on. As volumetric analysis is required, according to the syllabus, a little space has been devoted to this subject.

The Encyclopædia of Sport. Edited by the Earl of Suffolk and Berkshire, Hedley Peek, and F. G. Aflalo. Vol. II. (Laurence & Bullen.) Illustrated. This volume completes the Encyclopædia of Sport, the first volume of which we have already noticed. The whole work forms an admirable and trustworthy treatise on every branch of sport, and, indeed, everything connected with sport. No pains have been spared in obtaining authorities to deal with the various subjects, the volumes are well printed and bound, and the illustrations are generally excellent. We have nothing but praise for all those concerned in the production of this rich mine of information.

London in the Reign of Victoria (1837-1897). By G. Laurence Gomme. The Victorian Era series. (London: Blackie & Son.) 2s. 6d. In this new volume, the general editor of this excellent series may be congratulated upon the inclusion of an able and comprehensive sketch of the marvellous development of the great city during the Queen's reign. The nine square miles which formed the area of the London of 1837 has grown into the 120 square miles of 1897. As befits a statistical officer of the London County Council, Mr. Gomme is severely statistical, but he has exhibited great skill in collecting and compiling his store-house of facts. Our author is happiest when describing the London of 1837, with the aid of Fenimore Cooper and some other less distinguished visitors of that day. But when shall London's story be told—her history and traditions, the life and character of her people, her contrasts and comparisons, her restless activities and far-reaching ambitions, the terrible helplessness and hopelessness of so many thousands of her people? Mr. Gomme has no room and "scarcely any heart" for this, but we hope to see arise a son of the city who shall proudly tell her story as it deserves to be recorded, not in the patronising air so unhappily adopted by Sir Walter Besant, not from the point of view of the statistician or the courier, but as the Life and Letters of a great heart. Until the advent of such a writer, such books as Mr. Gomme's, and the altogether admirable guide book of Mrs. E. T. Cook, do good service in the cause.

The Living Organism. By Alfred Earl, M.A. (Macmillan.) 6s. Chemical and physical changes, we know, enter largely into the composition of vital activity, but, says our author, "there is much in the living organism that is outside the range of these operations." True, too much is taken for granted by many of those who have the courage to grapple with the mystery of life, and the problems and generalizations of the science of living objects are regarded too complacently by most students. In this book an effort has been made to present a broad general view of living things—a clear conception of the distinctive features of organic activity so far as the present state of knowledge on this complex subject will admit. To those persons, however, whose acquaintance with biological problems is extensive, the book will no doubt appear sketchy, and to the general reader, it strikes us, the wide scope, trenching as it does on every department of scientific enquiry, will present an almost inextricable labyrinth. Certain it is that in spite of the author's attempt to convey general notions to the exclusion of details, he has often afflicted his passages with terms that cannot be appreciated without special knowledge, and it may be doubted whether he has added a new note to the dignified theme he has selected for his essay.

Seismology. By John Milne, F.R.S. (Kegan Paul & Co.) Illustrated. 5s. Most of us are already acquainted with Prof. Milne as the author of "Earthquakes and other Earth Movements"—a standard work in this department of observational science. The book before us is a companion volume, some of the chapters bearing the same title as those in its predecessor; but it will be found that the subject matter of the new volume contains observations more extensive in character, and more trustworthy than were formerly obtainable—conditions which admit of the formulation of precise conclusions, some of which encroach on new ground. It is, for example, interesting to note that the art of recording earth tremors has now been cultivated to such a degree that we in England may know an earthquake has occurred somewhere, say in Japan, before it is possible to transmit the information to us by telegraph from the place of disturbance. Earthquakes are transmitted with incredible velocity in all directions, so that the "movements of the earth's crust can be equally well recorded and studied in England and other non-volcanic countries as in the most frequently earthquake-shaken districts in the world." Considering that at present the number of observers working in this interesting field of research may be counted on one's fingers, it is remarkable that such refinement in the modes of observation should have been attained before the scientific world has thoroughly awakened to the importance of the subject; for important it certainly is. In a chapter on "Movements of the Earth's Crust in Relation to Physical Research and Engineering," attention is directed to the errors and annoyances to astronomers and physicists caused by earth tremors; regarding engineering it is pointed out how by the use of seismographs along the coast of Japan submerged areas of seismic activity have been mapped through which it would be dangerous to lay a cable. In 1888 three cables connecting Australia with Java were fractured simultaneously by seismic disturbances, and Australia called out the naval and military reserves on the supposition that their sudden isolation indicated an operation of war; hence the importance of being able to say whether this was brought about by natural or artificial means cannot be over-estimated. The study of seismology will enable us to do this. Prof. Milne gives a very full bibliography of seismological literature at the end of the book, and numerous references are scattered throughout the text.

Michael Faraday: His Life and Work. Century Science Series. By Prof. Silvanus P. Thompson, F.R.S. (Cassell). Illustrated. 3s. 6d. In this volume, of about three hundred pages, Prof. Thompson gives us a most fascinating sketch of "the greatest scientific expositor of his time," embracing the domestic, scientific, and religious aspects of Michael Faraday's life—a sympathetic and appreciative account of the most striking scientific career of the nineteenth century. The son of a blacksmith, who had come from Yorkshire to Newington-Butts, Faraday was born there in 1791. From the age of five to thirteen he lived over a coach-house in Jacob's Well Mews, Manchester Square; he was apprenticed to a bookbinder, and read the scientific books which passed through his hands. When about the age of twenty-one years, he attended Davy's lectures at the Royal Institution, took careful notes, and submitted them to Davy, asking for scientific employment. "Early in 1813, the humble household in which Faraday lived with his widowed mother, in Weymouth Street, was startled by the apparition of Sir Humphry Davy's grand coach, from which a footman alighted and knocked at the door. . . . At that interview Davy asked him whether he was still desirous of changing his occupation, and offered him the post of assistant in the laboratory." By the following October, Davy and Faraday were touring through France, Switzerland, and Italy, and the young philosopher had to grin and bear the distinction or indignity of being sometimes treated as a sort of valet, although the chief scientific men of the Continent "admired Davy"—"loved Faraday." He was, in 1821, made superintendent of the house and laboratory of the Royal Institution, and married, living a happy life on one hundred a year. Fees for conducting chemical analyses and expert work in the law courts augmented his pecuniary resources, and "he might easily have earned £5000 a year had he chosen to cultivate the professional connection thus formed." But he never cared for money for its own sake, and, moreover, it was against his religious convictions to enrich himself. Faraday never took out patents for his discoveries; when they began to possess a marketable value from their application to industry he left them alone, preferring to pursue his pioneering in other branches. In 1835 he received a Government pension of £800 a year, and in 1858 a comfortable house for life on the green, near Hampton Court. He died, painlessly and peacefully, sitting in his chair in his study, on the 26th of August, 1867. Professor Thompson has shed many sidelights on the various phases of Faraday's life, and his book will help to deepen the interest in a character almost unique in the annals of science.

London University Guide and University Correspondence Calendar, 1898-9. (University Correspondence Press.) Gratis. A fund of information is given in this book relative to University examinations, and the means by which aspiring students may force their way to the coveted object—a University degree. Courses of study, and the books suitable for each, are sketched out in such a way that, whatever the needs of the scholar may be, the preliminary labour necessary to find out the means towards the end in view is reduced to a minimum. Degree hunters owe much to the publishers of this useful work, and the best thing we can do, seeing that the book is issued gratis, is to advise all students seeking University honours to avail them-

XUM

selves of the opportunity of securing its friendly guidance and help in their laudable aims.

The Last Link. By Ernest Haeckel. (Black.) 2s. 6d. Prof. Haeckel here goes over, critically, the evidence and the different conclusions which at present represent our scientific knowledge of the descent of man and of the various stages of "his animal pedigree." The book is a reprint of his address in August last at the Fourth International Congress of Zoology at Cambridge. A series of biographical sketches of Lamarck, Saint-Hilaire, Cuvier, Baer, Mueller, Virchow, Cope, Koelliker, Gegenbaur, and Haeckel, is added by Dr. Hans Gadow, as well as chapters on "Theory of Cells," "Factors of Evolution," "Geological Time," and so on. As we have long since learned to expect, there is no "beating about the bush" in Prof. Haeckel's manner—only one construction can be put upon his words. Evolution, as taught by Darwin, is his watchword. "Whence our race has come; what are the limits of our power over Nature, and of Nature's power over us; to what goal are we tending—these are the problems which present themselves anew and with undiminished interest to every man born into the world." On these matters the professor exercises his powerful reasoning faculties, and the result is full of interest, whether we are at one with him or not.

The Structure and Classification of Birds. By Frank E. Beddard, M.A., F.R.S. (Longmans.) Illustrated. Mr. Beddard's papers on the structure of birds are well known to those who attend the meetings, or read the Proceedings, of the Zoological Society. In this book Mr. Beddard has brought together the results of the researches into the anatomy of birds undertaken by himself and his two predecessors, Prof. Garrad and Mr. W. A. Forbes, in the office of Prosector to the Zoological Society. Some one hundred and fifty pages of the book are devoted to a general sketch of bird structure, in which the author has avoided "histological detail, and the elaborate description of anatomical facts, which are not, in the present state of our knowledge, of great use in classification." The main portion of the book consists of detailed accounts of the structure of different groups of birds. The author has a wide knowledge of his subject, and expresses himself with clearness and directness. The book contains a multitude of facts, elucidated in many cases by excellent illustrations. It should prove of great service to those who are working at the anatomy of birds, as well as to those who wish to use it merely as a work of reference.

It is refreshing to see such a well arranged, neatly printed, and tastefully illustrated catalogue of chemical, metallurgical, bacteriological apparatus, and pure chemicals, as that just issued by Messrs. Becker & Co. It has a very complete index, contains nearly seven hundred pages and three thousand five hundred illustrations. A pleasing feature is that the figures in nearly every case are placed opposite the number and the matter describing them. The catalogue includes many new pieces of apparatus which we have not previously seen in publications of this kind. The volume is well bound and has a very attractive appearance.

The Heavens at a Glance, a handy card calendar for 1899, by Mr. Arthur Mee, F.R.A.S., is this year printed in type, and in several other points is a great improvement on previous issues.

We have received from Mr. Wm. Harbutt, of Bath, a sample of his new modelling material, "Plasticine."

BOOKS RECEIVED.

Volcanoes. By Prof. T. G. Bonney, D.Sc., F.R.S. (Murray.) Illustrated. 6s.

The Science of Life. By J. Arthur Thomson. (Blackie.) 2s. 6d.

Practical Zoology. By A. Milnes Marshall and C. Herbert Hurst. Fifth Edition. (Smith, Elder & Co.) Illustrated.

Landmarks in English Industrial History. By George Townsend Warner. (Blackie.) 5s.

Birds. By A. H. Evans, M.A. The Cambridge Natural History. (Macmillan.) Illustrated. 17s. net.

West African Travels. By Mary H. Kingsley. (Macmillan.) Illustrated. 21s. net.

In the Australian Bush. By Richard Semon. (Macmillan.) Illustrated. 21s.

Outlines of Industrial Chemistry. By Frank Hall Thorp, PH.D. (Macmillan.) Illustrated. 15s. net.

A Retrospect of Eight Decades. By Rev. Edward L. Berthon. (Bell.) 5s. net.

The Sound of a Voice that is Still. By Archie Campbell. (Redway.) 5s. net.

Wonders of the Bird World. By R. Bowdler Sharpe. (Wells, Gardner, Darton & Co.) Illustrated. 6s.

The Story of the Mind. By J. M. Baldwin. (Newnes.) Illustrated. 1s.

Kant on Education. Translated by Annette Churton. (Kegan Paul.) 2s. 6d. net.

A Course of Wood-Carving according to the Japanese Method. By Charles Holme. (Offices of the *Studio*.) Illustrated.

Whitaker's Naval and Military Directory, 1899. 5s.

Siddhánta-Darpana—a Treatise on Astronomy from the Chinese. Edited by Jogés Chandra Ráy, M.A. (Indian Repository: Calcutta.) Three Rupees.

Remarkable Comets. By W. T. Lynn. (Stanford.) 6d.

Calendar and History of the Science and Art Department. (Eyre & Spottiswoode.) 1s. 8d.

La Nouvelle Monadologie. Par Ch. Renouvier et Louis Pratt. (Armand Colin et Cie: Paris.) 12 fr. Vol. XVI.

The Auk: a Quarterly Journal of Ornithology. Vol. XVI. No. 1, Jan. (Foster: New York.) Illustrated. 75 cents.

Dynamics. By Wm. Briggs and G. H. Bryan. (Clive.) 3s. 6d.

Practical Work in Physics. By W. G. Woollcombe. (Clarendon Press.) Illustrated. 2s.

A Short Way out of Materialism. By Hubert Handley. (Rivingtons.) 1s. net.

Archives of the Röntgen Ray. November, 1898. (Rebman Publishing Co.)

SUNSET ON THE MARE CRISIUM.

By E. Walter Maunder, F.R.A.S.

THE principal object in the accompanying plate is the Mare Crisium; one of the best studied of all of the lunar "grey plains." It is the most sharply defined and completely outlined of its class, and, so far as we can judge, it is the deepest, deeper even than the Mare Serenitatis, which lies in the same quadrant, and which it resembles in that the enclosed plain is divided into two regions at different levels; a broad marginal zone surrounding a central area which lies considerably lower. The frequency with which it has been observed is, no doubt, partly due to its being visible during the first half of the month. It will be noted that at the time when the photograph was taken the sunlight was already leaving the Mare, although the moon was but two and a half days past the full. It is thus an object for study in the evening hours, not the morning. If we add to this its small dimensions among the Maria, rendering it an object that may be easily studied as a whole, and its complete separation from other regions of its class—for it stands amongst lunar "Seas" as the Caspian amongst the waters of our own world—its attractiveness to selenographers is sufficiently explained.

Its very separateness, however, places the Sea of Crises in a somewhat different category to the Maria generally. The evidences, which are so abundant elsewhere of the destruction of ring-plains and crater-plains, by the material which forms the floor of the Mare, are scarcely to be noted here. On the other hand, though strongly resembling not a little in some of its characteristics the great walled plains like Clavius and Schickhardt, its far greater area forbids its being ranked with them, since even Clavius is but one-fifth the size.

Near the opposite limb of the moon, and practically on the same diameter, is another small Mare, smaller than the Crisium, and almost as completely isolated. These two "Seas" form the ends of a great arch composed of the greater Maria, which seem to follow one another like beads strung on a thread. It has often been pointed out that this arrangement seems to indicate that at one time they marked out the lunar equator, for they lie nearly on a

XUM

SOUTH.

WEST. EAST.

NORTH.

SUNSET ON THE MARE CRISIUM.

From a Photograph taken 1896, July 26d. 21h. 14m. 25s.—33s., Greenwich Mean Time, with the 36-inch Refractor of the Lick Observatory, Mount Hamilton, California. Scale: Diameter of Moon = 36·0 inches; Moon's Age, 16d. 13h.

XUM

great circle; whilst the tendency of the Maria to increase in size as we approach the centre seems to suggest that the influence of our earth was in some way or other the chief determining cause in their formation.

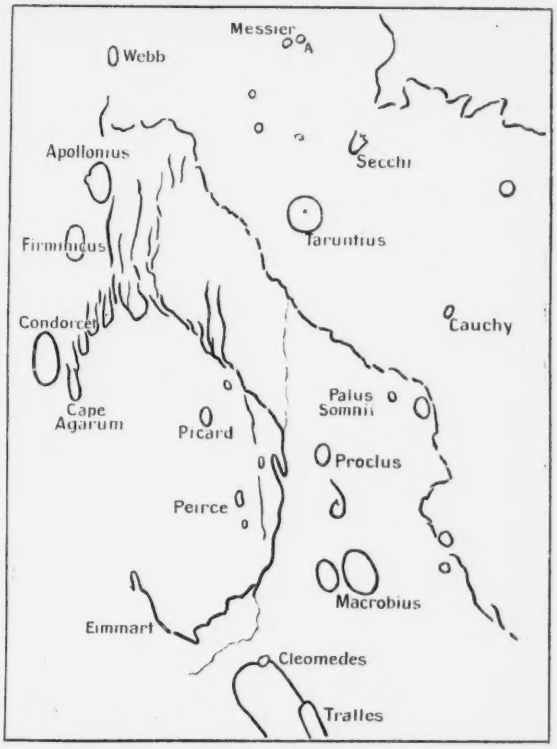
It is fully recognised now that the "Seas" are amongst the most recent of lunar formations. We cannot otherwise explain the traces of submerged ring-plains to be seen here and there in the Maria themselves, and the numerous instances of partially demolished rings which border them —the destroyed or injured rampart being always on the side nearer the "Sea." Leaving altogether on one side the question of any change in the lunar axis as one too curious for our present information, this disposition of the Maria seems to point us backward with no uncertain finger to the time when the moon ceased to rotate as viewed from the earth. Up to that time the earth had of course an equal effect on every meridian; from that time it has been dominant over the centre of the apparent disc.

Mr. N. E. Green, truest of astronomical artists, and most experienced of selenographers, has suggested that it was the final set of the great lava tide which the earth produced on the moon which gave rise to the "Seas." The suggestion can hardly be far from the truth, and we are thus able to say that the time when the lunar rotation came into complete accord with the month was also the time when its crust was approaching solidification but had not reached it. It was also the time when our own earth was still emitting so much heat as to have a vast influence upon its satellite. For there is a very marked resemblance between the character of the polar regions of the moon and of the limb in general—a circumstance which has long been recognised, but to which MM. Loewy and Puiseux have given fresh importance by their studies of the photographs they have taken with the equatorial coudé of the Paris Observatory.

Whatever was the particular mode in which the final formation of the "Seas" was effected, and however it may differ from its greater brethren, the Mare Crisium evidently took its formation about the same time, and in the same way. This is indicated by the meridional ridges which mark its surface. Sunset, in our photograph, has advanced too far for most of these to be seen, but two can be made out pretty clearly.

Studying the Mare as it appears to-day, we find that its border differs much in its character in different parts. Our photograph brings out the character of these on the east and south in strong relief. On the east the cliffs are bold and precipitous, broken by only one important pass, which is near the centre, and is fully shown on the plate. On the south a number of valleys run up from the Mare into the Highlands, which form on the photograph a particularly bold and interesting region, full of striking detail. These Highlands curve round towards the north, and end in Cape Agarum, a bold promontory which is just receiving the last rays of the sun. Curving to meet this from the north is a similar, but less striking, promontory, which is all but lost in the darkness of approaching night. These two opposite points mark the opening of a deep bay, not seen in the photograph, as it has already passed into the lunar night. But for this bay the Mare Crisium would be roughly circular, its length and breadth being nearly equal. More accurately, it would be hexagonal, the tendency of the outlines of the great lunar formations being to take a polygonal rather than a circular shape. The bay, however, narrow as it looks to the eye through the effect of foreshortening, brings the greatest length east and west of the Mare up to three hundred and fifty-five miles, whilst its length north and south is but two hundred and eighty. The bay is further distinguished from the rest of the Mare, in that the greenish tint which can be seen over the greater portion of the floor under high illumination does not extend beyond Cape Agarum.

The region embraced by the plate is one that, more than most districts of the moon, supplies a considerable variety of colour. As already mentioned, the dark floor of the Mare has a certain greenish tinge, which is absent beyond Cape Agarum, and in the great ring-plain Condorcet, which lies just to the south of that promontory in the darkness. East of the Mare, on the other side of the great pass already referred to, lies the Palus Somnii, its further border strongly marked out by contrast with the dark Mare Tranquillitatis, which comes up so dark in the photograph. The Palus is described as of a peculiar yellow, almost amounting to a golden brown, whilst round the great



Sketch Map.

ring-plain Taruntius, which stands in the full sunshine due south of the Palus, Elger notes a very decided sepia colour under a low sun. Moving nearly due west from Taruntius, the ring-plain Firminicius lies in the darkness, beyond which is a curious mountain with triple peaks. Round this, on the surrounding plain, appear broad, dark grey streaks, which undergo apparent changes of a periodical character, and which Mädler suggested might be due to vegetation. The floor of Mare Crisium, too, has sometimes been noticed to be sprinkled with minute bright points, which Mathieu Williams ascribed to hoar-frost.

The region therefore is full of interest from the point of view of real or apparent periodic change. It includes also a pair of objects which supply us with perhaps the best attested example of intrinsic change. These are the two crater plains Messier and Messier A, at the extreme south of the plate. It will be seen that the more westerly Messier is distinctly the smaller of the two, and whilst Messier A, the larger and more easterly crater, is nearly circular, its companion is as distinctly elliptical and

XUM

elongated in an east and west direction. Now Mädler drew and described the two as exactly alike in every respect, and Beer and Mädler examined this pair more than three hundred times between 1829 and 1837, without noticing any change. Schroeter, on the other hand, whose observations preceded those of Mädler by more than a quarter of a century, drew the western crater as the larger. Webb, in 1855, found this inequality had been reversed. Its appearance as he then recorded it corresponds with that which the photograph shows and which it retains to the present day.

THE PLANET EROS (D Q, 433).

A CAREFUL search has been made by Mrs. Fleming upon the Harvard plates for early photographs of Witt's Planet (433) D Q. Mr. S. C. Chandler has courteously furnished ephemerides based upon the best available material, and has devoted much time to correcting the elements and computing the positions corresponding to the times at which certain photographs were taken, as is more fully explained in the *Astronomical Journal*, No. 452.

In making this search the following method of procedure has been adopted. Mr. Chandler, by means of the elements published in the *Astronomical Journal*, No. 451, computed ephemerides for the oppositions of 1894 and 1896. It appeared that the observations then available were insufficient to determine the position in 1894. An error of one second in the mean daily motion in the orbit would change the right ascension of the object in 1894 by about half-an-hour. Moreover, the value of the daily motion differed by several seconds not only in the early ephemerides of this planet, but in those dependent on a large number of visual observations. Although plates were examined by Mrs. Fleming, covering a region of about one thousand three hundred square degrees, the planet was not found. Plates taken in 1896 were next examined, as it was thought that the smaller errors of the ephemeris would compensate for the extreme faintness of the planet. This examination proved to be especially laborious and fatiguing to the eyes. It was feared that the object might be too faint to appear upon the plates, and accordingly the faintest objects were carefully scrutinized.

Each plate was examined by superposing it upon another plate of the same region taken with the same instrument. Two adjacent images then appeared of each star, while the planet, if present, would appear only upon the upper plate. Numerous suspicious objects were thus found, including several images of the planets Flora (8) and Nysa (44), and two new variable stars, whose approximate positions for 1900 are in R. A. 8h. 33·9m., Dec. +50° 29′, and R. A. 18h. 38·7m., Dec. −38° 52′, were discovered. The star +29°551 fails to appear on ten plates which show other faint Durchmusterung stars, and two stars at R. A. 9h. 11·4m., Dec. −10° 43′, and R. A. 9h. 11·5m., Dec. −10° 16′, appear upon the Durchmusterung charts and upon the photographic plates, but are not given in the Durchmusterung catalogue.

At last a faint image was found on a plate taken on June 5th, 1896, and confirmed by other plates taken on June 4th and June 5th. A plate taken on April 6th covered the region of the planet, which was readily found by means of its computed position. Mr. Chandler, from positions of these images, was enabled to furnish a corrected ephemeris for 1894, by means of which the planet was readily detected on several plates.

The following elements have been computed by Mr. Chandler, by combining the observations of 1898 with those derived from the photographs taken December 19th and 27th, 1893, February 16th, 1894, April 6th, 1896, and June 4th and 5th, 1896 :—

Elements.

Epoch 1898, Aug. 31·5, Gr. M. T.
$M = 221° 35′ 45·6″$
$\omega = 177° 37′ 56·0″$
$\Omega = 303° 31′ 57·1″$ } 1898·0.
$i = 10° 50′ 11·8″$
$\phi = 12° 52′ 9·8″$

$\mu = 2015·2326″$
$\log a = 0·1637876$
Period = 643·10d.

December 26th, 1898.

The above method of search for Eros (433) has been continued. The ephemeris has been extended by Mr. Chandler, as required, and images of the planet have been found by the writer on thirteen plates, three plates being taken at Arequipa, the others at Cambridge.

The earliest of these photographs, taken October 28th, 1893, is important, since, with that taken on May 19th, 1894, the anomaly through which the planet was observed in 1893–1894 becomes 162°.

The orbit of the planet could be well determined from the observations in 1896 alone, using for the first place the position of April 6th, for the second the three positions on June 4th and June 5th, and for the third the photographs taken on June 29th and 30th.

Some important conclusions may be derived from this investigation. All the photographs on which the planet has been found were taken with doublets. If they had been taken with lenses of the usual form, with a field two degrees in diameter, all of the images would have fallen outside of the plates. In view of the difficulties found in photographing this object with an ordinary lens at Greenwich and Oxford (Observatory XXI., 429), it is doubtful whether we should have obtained many images of it here with such a lens, even if it had been in regions photographed. The number of plates on which the planet appears probably fairly represents the number we have of all other similar objects, whether already discovered or not. This planet is bright during only a small portion of time. During the last eleven years it has been brighter than the ninth magnitude, photographically, for only two months, or about a seventieth part of the entire time. There may be other similar objects, even brighter, as yet undiscovered. Nova Aurigæ was as bright as the fifth magnitude for six weeks before it was discovered. Had Eros attained the sixth magnitude instead of the eighth, it should have appeared on plates taken with the transit photometer. In this case, we should have had an image of it on every clear night on which it culminated after dark. Fairly good positions could have been obtained from these images, since the focal length of the telescope is about two feet, and the exposures are so short that the images are always circular. We have now a similar instrument in Arequipa, so that in general two images should be obtained every night.

January 16th, 1899. Edward C. Pickering.

Letter.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

LONGITUDE OF THE EARTH'S PERIHELION.

To the Editors of Knowledge.

Sirs,—I should esteem it a favour if one of your readers or contributors would be good enough to explain the apparent discrepancy between the longitude of the earth's perihelion, as given in the appendix to Sir R. Ball's

"Elements of Astronomy," viz., 100° 21′ 21·5″ in 1850, according to Leverrier, and the longitude required in order that it may take place on 31st December last at 10 p.m., according to the *Nautical Almanac*. If the longitude in 1850 was 100° 21′ 21·5″, and the annual increase is 61·72″ (50·238″ + 11·482″), the longitude in 1898 should have been 101° 10′ 44″, *i.e.*, 11° 10′ 44″ beyond the winter solstice, which angular distance it would take the earth, travelling at its *maximum* orbital velocity (61′ 9″ per diem), ten days twenty-three hours fifteen minutes to traverse, thus bringing us to 6h. 15m. p.m. on 1st January (taking winter solstice at 7 p.m. on 21st December), instead of the time given in the *Almanac*. The sun's apparent longitude at noon on 31st December, according to the *Almanac*, was 279° 53′ 31·9″, which would make the earth's 99° 53′ 31·9″, adding 23′ 28·75″ for the ten hours makes 100° 17′ 0″, which is 4′ 21·5″ less than Leverrier's figures for 1850. If those figures are wrong, why are they given in the last edition of Sir R. Ball's book above mentioned?

PERPLEXED.

[The discordance is due to the perturbation of short period which the moon and planets produce on the earth's motion. Perturbations are divided into two classes, secular and periodic. The advance of the perihelion through 11·48″ per annum (or through 61·72″ referred to the vernal equinox) is a secular perturbation. These secular perturbations have the effect of causing the earth's elliptical orbit to slowly vary, the variations being for long periods uniform both in direction and in amount. The periodic perturbations cause the earth to oscillate from one side to the other of this slowly varying ellipse. One of these perturbations is very easy to understand; it is due to the earth describing a small ellipse once a month about the centre of gravity of the earth and moon; owing to this motion the earth's centre is alternately inside and outside the mean orbit by an amount of some three thousand miles. The planets produce the waves in the earth's motion of large periods and of complicated forms. Hence it is clear that the position of the earth when nearest the sun is not the same as the perihelion point of the slowly-varying ellipse which is given in the table quoted by "Perplexed." If, however, he takes the values for several years from the *Nautical Almanac* he will find that they fall sometimes on one side, sometimes on the other, of the values given by the formula he uses. For example, take the following cases:—

Time of Perihelion.	D.	H.	Longitude of Earth. °	′	Value by Formula. °	′
1896. January	1	7	100	56	101	9
1896. December	30	22	100	18	101	10
1898. January	2	1	102	13	101	11
1898. December	31	10	100	19	101	12
1900. January	1	18	101	26	101	13

In three cases the actual longitude is below the tabular, and, in two cases, above it.]

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

ON THE COMPARATIVE AGES TO WHICH BIRDS LIVE. By J. H. GURNEY, F.Z.S. (*Ibis*, January, 1899, pp. 19-42).—In a very interesting article under the above title, Mr. Gurney, after deploring our want of knowledge on the subject, discusses a number of facts, collected from various books and papers, regarding the age to which birds live. Stories of birds having lived to enormous ages are, of course, plentiful. Of more or less authentic records, the greatest age, that of eighty-one years, seems to have been attained by a sulphur-crested Cockatoo. A domestic Goose was recorded by Willughby as having been killed on account of its destructiveness at the age of eighty. A Mute Swan, called "Old Jack," died at the age of seventy in St. James' Park in 1840. Mr. Dresser, in his "Birds of Europe," gives an instance of a Raven having lived sixty-nine years. Mr. Meade-Waldo has in captivity a pair of Eagle Owls (*Bubo maximus*), one of which is sixty-eight and the other fifty-three years old. Since 1864 these birds have bred regularly, and have now reared ninety-three young ones. A Bateleur Eagle and a Condor in the Zoological Gardens at Amsterdam are still alive at the respective ages of fifty-five and fifty-two. An Imperial Eagle of the age of fifty-six, a Golden Eagle of forty-six, and a Sea Eagle of forty-two, and many other birds of the age of forty downwards are also recorded. Mr. Gurney discusses the probability that some families or even allied genera of birds may attain a greater age than others, but owing to the want of information no satisfactory conclusion can be arrived at. The author suggests that wild birds might be marked with an aluminium or white metal ring, bearing date and name of place.

The Rufous Warbler, a bird new to Ireland (*Irish Naturalist*, February, 1899, p. 52).—Mr. R. J. Ussher announces that a supposed Nightingale, preserved for twenty years in the museum of Queen's College, Cork, and now faded, has been identified by Mr. Howard Saunders as a Rufous Warbler (*Aedon galactodes*), a southern species which has been obtained in England only three times, and has never before been recorded for Ireland. The bird was shot by Mr. F. R Rohu, at the Old Head of Kinsale, in September, 1876.

Woodchat Shrike, a bird new to Ireland (*Ibis*, January, 1899, p. 158).—Mr. Richard M. Barrington writes to the *Ibis* that in 1893 he received from Mr. Patrick Cullen, master of the Blackwater Bank Lightship, County Wexford, the leg and wing of a bird killed by striking the lantern on August 16th. Mr. Barrington has lately sent the wing and leg to Mr. Howard Saunders, who recognized them at once as belonging to the Woodchat Shrike (*Lanius pomeranus*), a bird which has never before been known to occur in Ireland.

Nesting of the Goshawk in Yorkshire (*Zoologist*, January, 1899, p. 28).—An adult female Goshawk (*Astur palumbarius*), together with two of its eggs, have recently been presented to the Norwich Castle Museum. Mr. Thomas Southwell states that the bird was shot at its nest about May 13th, 1893, by Mr. W. M. Frank, a keeper on an estate at Westerdale, Grosmont, Yorkshire. The only question is: Was this a truly wild bird, or an escaped one? In commenting upon this question, Mr. Southwell says that the keeper is unable to state with certainty as to whether the bird had a mate or not; that the bird was very wild; and that "the inner toe of the right foot is missing, evidently an old injury, as the stump is quite healed." Should anyone have lost a Goshawk in the early part of 1893, the loss of the toe may lead to its identification. Mr. Southwell remarks: "Since the instance reported by Colonel Thornton, who received a nestling from the forest of Rothiemurchus, 'prior to 1804,' I believe there is no authentic instance of its having bred in Great Britain, although it has been suspected of having done so."

Richard's Pipit in Cumberland (*Ibis*, January, 1899, p. 155).—The Rev. H. A. Macpherson has identified a specimen of *Anthus richardii*, which was shot by Mr. Tom Williamson, on October 10th, 1898, on Edderside Moss, near Allonby, Cumberland.

Barred Warbler in Oxfordshire (*Ibis*, January, 1899, p. 160).—Mr. O. V. Aplin obtained a specimen of *Sylvia nisoria* on November 28th, 1898, at Bloxham, Oxon. Mr. Aplin remarks that this specimen (the sixteenth procured in these Islands) "had wandered further inland than any of the other Barred Warblers which have straggled to our shores."

The Introduction of the Black Grouse and of some other Birds in Ireland. By G. E. H. Barrett-Hamilton, B.A., F.Z.S. (*Irish Naturalist*, February, 1899, pp. 37–43).—This is a careful paper, dealing chiefly with the many unsuccessful attempts which have been made from time to time to introduce the Black Grouse into Ireland.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Science Notes.

A site has been secured at Kemp Town, overlooking Queen's Park, Brighton, for the Gardens of the recently founded Zoological Society for Brighton and Hove. Some sixty years ago Brighton possessed a small zoological garden situated north of The Level, on the Lewes Road. The institution did not flourish owing to the ignorance of its originators, who had no notion of the proper method of dealing with captive specimens. The consequence was a very high death-rate, and a brief career for the institution. The new garden will not be likely to fail from the causes which produced the collapse of its predecessor, for it will be managed by competent zoologists who have experience in the treatment of animals of all kinds. Moreover, the encouragement held out to the projectors by residents and persons of distinction in Brighton is such as to warrant us in believing that the undertaking will prove to be a success in all respects. A special feature in the new institution will be the regular delivery of courses of instructive popular lectures for the benefit of the numerous schools in Brighton and Hove. Among those who have enrolled their names as patrons of the Society are several of the foreign Ambassadors, the Duke of Fife, Sir John Lubbock, Sir Edward Sassoon, the Earl of Chichester, and the Hon. Walter Rothschild. The managing-directors are the Earl of Landaff and Mr. F. W. Frohawk.

Messrs. Taylor, Taylor, and Hobson have sent us an improved circular spirit level. The spirit chamber, made by squeezing from a flat sheet of German silver, being of white metal sharpens the contrast between the bubble and the surrounding spirit, and a compensating joint so effects the combination of the cover glass and spirit chamber that expansion of the metal does not cause leakage by rupture. Further security against leakage is effected by an elastic guard ring compressed into the angular space of the joint, and an outer jacket, separated from the spirit chamber, protects the cover glass from injury. The instrument is, indeed, a very compact, useful, and attractive bit of workmanship.

In our December number, 1898 (p. 275), we recorded the fact that Prof. Howes had received some eggs of the New Zealand lizard *Sphenodon*, and several of these which were carefully kept have now hatched out. The young lizards are in fine condition.

The Marine Biological Laboratory, founded in Brittany by M. de Lacaze-Duthiers, has been the scene of some interesting experiments on the artificial formation of pearls in Gastropods. The mollusc chosen by M. Louis Boutan, who conducted the experiments, was *Haliotis*, of which even the European species occurring in the English Channel has a fine pearly inside surface to its shell. After a series of unsuccessful attempts, some really fine pearls were obtained by trepanning a small part of the shell and introducing a foreign substance.

Our attention has been directed to a device for effecting a more complete combustion of coal or coke in the house. The patent "Automiser" involves in its construction a contrivance which is of great use in certain furnaces for metallurgical operations, namely, hot-air chambers, which augment in a remarkable degree the heating effect. The "Automiser" is equivalent to a hollow brick open at the bottom and having a tranverse slit across the front. When this is put in the grate, in place of an ordinary fire-brick, the air enters the chamber from below, and, becoming heated with the surrounding fire, is deflected from the curved surface above, the hot air emerging through the tranverse slit at such an angle as to impinge on the fuel in the grate.

Mr. Whymper has recently put the Watkin mountain aneroid to a severe test. Travellers or surveyors may be led to exaggerate their altitudes in climbing through the error caused by diminution of pressure; thus, Mr. E. A. Fitzgerald says, in the *Geographical Journal*, November, 1897, "Our aneroids played us some very curious tricks. One of them, on being taken to a height of nineteen thousand feet, registered twelve inches," that is to say, it indicated an altitude of twenty-five thousand feet, and was therefore about thirty per cent. in error as compared with the mercurial barometer. This loss in the aneroid depends (1) upon the duration of time it may be submitted to diminished pressure, and (2) upon the amount of the diminution in pressure. Colonel Watkin attacks the problem of correcting this error by relieving the strain on the mechanism of the aneroid and only permitting of its being put in action when a reading is required. This is effected by attaching to the lower portion of the vacuum-box a screw arrangement, actuated by a fly-nut on the outside of the case, which, when a reading is required, is screwed up as far as it will go, thus bringing the instrument into the normal condition in which it is graduated. An inspection of the accompanying table, showing comparisons of the aneroid with the mercurial barometer at different altitudes, ascent and descent, will indicate that the error has been practically eliminated:—

A Place of Observation.	B Date. 1898.	C Altitude.	D Merc. Bar. reduced to 32° F.	E Watkin Mountain Aneroid.	F Number of Observations.	G Mean error of Aneroid.
			Inches.	Inches.		Inch.
Zermatt	Sept. 3-8	5,315 ft.	25·006	25·096	21	+ 0·090
Top of Gugel ...	,, 9	8,882 ,,	21·963	22·020	1	+ 0·057
Top of Gornergrat	,, 9	10,289 ,,	20·872?	20·820	1	− 0·052?
Randa	,, 15-17	4,741 ,,	25·687	25·687	6	0·000
St. Nicholas ...	,, 17-22	3,678 ,,	26·443	26·424	5	− 0·019
Visp	,, 23-29	2,165 ,,	27·726	27·720	3	− 0·006
Sierre	Oct. 9-12	1,765 ,,	28·131	28·121	5	− 0·010
Geneva	,, 13-17	1,227 ,,	28·332	28·302	2	− 0·030

The instrument is made by Mr. Hicks, of Hatton Garden.

To the account of sanitary Bibles for witnesses to kiss, must be added the recent adoption by the Savings Bank in Brussels of a process for sterilizing the bank notes which pass through the establishment. This consists of exposing the paper money to the vapour of formalin for several hours. The *Révue Scientifique*, commenting on the fact, calls attention to the necessity which exists for disinfecting the books that are lent out from public libraries and institutions, and which often pass through various dangers of gathering harmful germs before being returned again.

ELECTRICITY AS AN EXACT SCIENCE.

By Howard B. Little.

II.—UNITS AND MEASUREMENTS.

It is no doubt tolerably safe to assume that a bargain of some kind was pending when primitive man attained to his first notion of measurement. Probably one of the high contracting parties (he of the keener commercial spirit) demanded, in pre-historic word and tone, "more than that." Arbitration, or trial by

combat, may have ensued. But the important point for our consideration is this, we may again assume that the commodity of which more was first demanded was a food-stuff. Oliver Twist's demand was only novel in a relative sense, while that which we are considering is novel from hypothesis, but its meaning, we need not hesitate to say, was relative. More, or the synonymous expression was used.

Leaving for the moment this distinction between relative and absolute measurements, we come to another point of view, and ask, "What was the physical quantity which first became an article of barter?"

As regards the transaction alluded to, the answer would appear to be weight. But that is a popular error, if the purchase had to be conveyed any distance the weight would be a distinct nuisance. This graphic distinction between weight and mass is, I think, due to Prof. Olaus Henrici. A little reflection shows us that the physical quantity first purchased or bargained for is more than likely to have been muscular energy. The ability to wield a primitive spade must have been early in demand, likewise the power to manipulate a club.

Now let us contrast this state of things with that existing at present. The great distinction lies in that our measurements are absolute, or referred to some recognized system of units. Following out the same train of ideas, we find that the commodity perhaps most marketable now is energy, or the means of producing energy. There is, however, one marked difference. With the growth of mental energy, muscular energy is being largely superseded by mechanical and physical energy. Gas and coal are purchased, because heat, light, or energy, are required, while electrical energy is actually sold at so much per unit. As it is this latter commodity with which we are to concern ourselves, it may not be out of place to note the following facts.

The so-called electric current is never sold. It flows through the consumer's apparatus, and, under ordinary conditions, every milliampère is scrupulously returned by him, if unconsciously. Nor is electrical pressure sold. It may be regarded as potential energy.

To bring these points out more clearly, let us consider a parallel case. The owner of a large pond, situated on the top of a hill, could never find a purchaser for the pressure which that volume of water exercised on the sides and bottom of the pond. But, if he were to let the water flow down the hill, to drive mills, turbines, and so on, it would become a distinct source of income to him, while at the same time he would not be justified in charging anything for the water if it all flowed into a lake of his own at the bottom of the hill. It is then kinetic energy which appears to be the article in demand.

I am to some extent ashamed of having used the expression potential energy here, though it serves so well to illustrate the point under discussion. What I would imply is, that if we define potential energy as the energy which a body has on account of its position, and kinetic energy as the energy derived from its motion, it is quite obvious that the difference is only one of degree.* If the potential energy of a body, or system, be increased, it will, when that increase is sufficient, be converted, or partially converted, into kinetic energy.

Returning to the consideration of electrical energy, and its measurement, we find that the commercial measurement of electricity is on a far more reasonable basis than the commercial measurement of almost any other article of commerce. By reasonable I mean practical, and, in consequence, scientific.

But let us examine this claim which I have put forward. Bread is sold by weight. No one ever required heavy bread yet. The play upon words is inevitable, and like so much of the inevitable, unfortunate. Bread is purchased because it can support animal life. It by no means follows that four pounds of bread purchased to-day is so well capable of supporting animal life as that which may have been obtained last month. Yet, the weight being the same, the same price is in all probability paid. Here electrical dealings can claim to be on a far more scientific basis than those which refer to "The Staff of Life," because the purchaser pays for that attribute of electricity which he requires, while in the other case he pays for what he does not require. And "electricity is only in its infancy," precocious child!! Curiously enough, if the same contrast be made between the rational commercial measurement of electricity, and the existing stupid measurements of the very necessaries of life, it will still give us the same result, and be entirely favourable to electricity. It may be urged that it would be "unpractical" to endeavour to gauge the number of units of heat obtainable from a given ton of coals. On the other hand, the use of the word "unpractical" is a distinct misuse in this connection, added to which, one is led to ask, Has any effort been made to render such a system common? Arrived, then, at the bald statement that the measurement of electrical energy is the direct measurement of what the consumer actually requires, we are in a position to state that this style of measurement is going on *automatically* in millions of places day and night. By comparison with the treatment "meted out" to our infant, most commercial measurements, of the very commonest and most necessary articles, seem to be based on systems that are distinctly in their dotage. A pint of milk is by no means the same thing all the world over, neither is a cubic foot of gas. But a watt is. Let us just in passing define the watt, and next consider how it is measured. A current of one ampère (unit current), propelled by a pressure of one volt (unit pressure), is precisely equal to one watt of electrical energy. But to form a working basis for the charges to be made to consumers, time, of course, comes into the consideration. Hence, the "Board of Trade" unit is ten thousand watt-hours. That is, ten thousand watts supplied for one hour, one watt supplied for ten thousand hours, or any intermediate manner of making up the product, as for the sake of simplicity we confine ourselves to the consideration of whole numbers just now.

For highly accurate measurements of current strength a silver voltameter is generally made use of, and the calculation is based on the fact that one ampère, flowing for one second, deposits 1·118 milligrammes of silver per second. Fortunately, however, there is a far more rapid method of making current measurements, which, as a natural consequence, is adopted in practice.

We know that a magnetic needle hung or pivoted with its axis parallel to a conductor will be deflected by the current in that conductor, and this angular deflection is a distinct measure of the current strength, where the force tending to keep the needle in its original position is of uniform magnitude, and the position of the conductor remains unchanged. Instruments, therefore, are made on this principle, then calibrated by comparison of their readings with the results given by a silver voltameter, when the same currents were passing through the two. The

* I am well aware that many people, possessing knowledge and wisdom superior to my own, have no hesitation in accepting potential energy as energy differing in *quality* from kinetic energy. Yet I would ask them to reconsider this doctrine.—H. B. L.

XUM

instrument thus calibrated is known as a galvanometer when its scale is marked in degrees, or some trigonometrical function of degrees. But, to still further facilitate rapid commercial measurement, the scale is usually arranged so that it reads directly in ampères, in which case it is termed an ampèremeter, or an ammeter. It is not possible here to refer to the very many electrical and mechanical details which have to be considered, and to conditions which have to be fulfilled, that the readings of such an instrument may still be accurate although the magnetic field in which it is used may vary within wide limits, and any spring forming an essential part of its movement might be subject to great changes in its resilience, while it will as a whole undergo great changes of temperature. Further, errors introduced by "hysteresis" must be eliminated, or, to be more accurate, precautions should be taken to prevent their introduction. Hysteresis has been popularly defined as "the past history" of the instrument (Prof. W. E. Ayrton, if memory serve), an excellently bad pun, and an excellently good definition in this connection, for it will easily be realised that if an instrument, depending for its action on electro-magnetism, be used first for the measurement of a relatively large current, and immediately afterwards to measure one of low strength, the residual magnetism (a part of that magnetism previously induced by the much larger current) will, if it be allowed to work its wicked will, affect the second reading.

Speaking broadly, then, the ammeter of commerce is an instrument which depends for its action on the fact that a mass of steel or iron will always tend to set itself in the strongest part of a magnetic field.

The measurement of electrical pressure, electromotive force, or potential difference (as under varying circumstances the same "attribute" of electricity is called), is of course referred to the volt. The volt is a derived unit; its derivation is not, however, far to seek. In order that a current of one ampère may flow through a conductor having a resistance of one ohm, the difference of potential at the terminals of that conductor must be one volt. And the ohm may be defined as the resistance of a column of mercury, at the temperature of melting ice, 14·4521 grammes in mass, of a constant cross-sectional area, and of the length of 106·3 centimetres.

Since the volt is thus derived from the ampère and the ohm, it is not surprising to find that so-called voltmeters are really instruments to register the current strength flowing through a wire of definite resistance. And since we know that the potential difference at the terminals of any conductor is the product of the resistance, in ohms, and the current in ampères in that conductor (Ohm's law), the instrument can be so constructed as to indicate directly in volts.

In one well-known type of direct reading voltmeter, the increase in length of a stretched wire is actually taken as a measure of the voltage, because the passage of current causes heating, and the greater the current the greater the heat and expansion produced. The wire usually employed for "stringing" this instrument is of platinum-silver, and very fine. This instrument (due, by the way, to Major Cardew) has had a vast deal of thought expended upon it, to bring it to its present accuracy. The rods supporting, or forming part of, the frame upon which the wire is strung are compounded of iron and brass, so that their temperature co-efficient shall be equal to that of the platinum-silver, yet inexpensive. If this precaution were not taken the pointer would move through a certain angle on account of external change of temperature. If one of these instruments be used with the tube which encloses the wire placed vertically, a certain amount of error is introduced, especially on the higher parts of the scale, as, the wire being considerably heated when this is reached, air currents are set up in the instrument and the needle will vibrate instead of taking up a definite position. If the tube be horizontal this will not occur.

The Cardew voltmeter is not affected in the least by external magnetism, and of course no temperature correction need be made, unless extreme accuracy is required, in which case the constant will be negative, and of the order, 0·03 per cent. per degree Centigrade.

There are many forms of voltmeter which may be regarded as high resistance ammeters. In using all such instruments the temperature correction is a most important factor, because there must be very many turns of fine wire (otherwise the potential difference to be measured would be destroyed by the insertion of the instrument forming an easy path through which the pressure could send a current), and these many turns would, by the rise of temperature, have their aggregate resistance proportionally increased.

This difficulty has been recently overcome by the introduction of an alloy termed "Ja Ja," which has a negative temperature resistance co-efficient. By therefore arranging for a coil of a metal having a positive co-efficient and an added resistance (of proper proportion) of "Ja Ja"—that Gilbertian name!!—the temperature co-efficient of the instrument may be made absolutely nothing.

We have thus the essential parts of a direct current direct reading wattmeter, an ammeter, a voltmeter, and a clock. On alternating circuits, where the direction of the flow may vary very many times a second, the condition of things is different, and it must be remembered, in considering the wattmeter, that the product of mean current by mean potential difference throughout a definite time will not, as a rule, be equal to the mean value of the energy expended.

In practical forms of the wattmeter, the ammeter coil usually has the voltmeter coil suspended within it, or a small coil, connected up as a voltmeter, which, in order to make up the required resistance, is joined in series with a resistance; if the latter is to have no electro-magnetic effect, it is wound "back on itself," or double, so that the inductive effect of each half of this counterbalances, and is counterbalanced by that of the other.

As regards the addition of the clock, which converts the wattmeter into what is popularly termed an "electricity meter," this part of the apparatus is brought into gear in various ways. The pendulum bob may be replaced by a coil of wire, so that the electrical energy affects the regulation, or the time-counting arrangement may be motor driven.

The want of space does not permit of the discussion of any further forms of electric measuring instruments, though we may in passing point out that the public had no faith in the registrations of electricity meters until some genius was struck with the idea of making them look like gas meters externally.

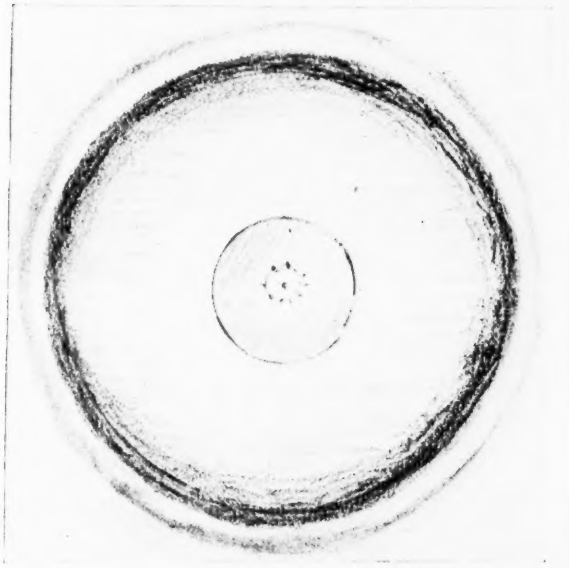
It has been quite impossible here to refer to the entire system of electrical units—indeed the Coulomb, Farad, Joule, and Sechom are practically left out. Before leaving the consideration of units it may be well to add that the late Prof. Fleming Jenkin's "Report to the Royal Society on the New Unit of Electrical Resistance," which, in conjunction with British Association reports, 1862 and 1869, were issued in book form, shows very plainly how complete a system of mutually depending units has been arranged. In this connection the story of the Board of Trade standards would be well worth looking up.

TRIPLE ATMOSPHERIC CORONA.

By the Rev. Samuel Barber.

ABOUT thirty years ago there was seen from the landing stage at Liverpool a solar halo and a corona at the same time. The writer hazarded the suggestion that a drift of sleet was the originating medium of both. This was confirmed, soon after, by a downfall of half-melted snow.

About the same time appeared a lunar corona of similar type to the one now figured and described, seen on



Christmas Day, 1898, about 8.30 p.m. The first-mentioned had the blue ring of a very intense colour, and appeared more steady, and was probably formed in a higher drift of particles. In this recent instance, the moon, two days off "full," was pretty bright, and a drift of broken cirro-cumulus, or "alto-cumulus" was rapidly passing from about west-north-west. The corona was very variable, and did not appear in perfection for more than a minute or two at a time, recurring again and again.

There was the usual small pale disc close to the moon,* with diameter equal to about three times that of the moon's disc. Then a larger disc of yellowish-grey edged by reddish-orange, and rounded off so as to give it a semi-spherical effect.† The diameter of this was seven or eight times as great as that of the inner disc. Outside the orange, again, was the beautifully coloured blue ring which makes this kind of corona so attractive in form. Then a ring of grey light as narrow or narrower than a rainbow. The blue ring was slightly wider than this outer grey one, and not so well defined on its inner edge.

The barometer was falling, and the temperature had risen before this appearance.

The weather for several weeks after was exceedingly stormy and changeable. A high wind was almost continuous for a long period.

For the explanation of these coronæ the reader is referred to Kaemptz, and any good treatise on optics, or Ganot's Physics. Not long ago the writer saw the corona illustrated beautifully in a Cornish field, where an immense deposit of gossamer had taken place during the night. Upon the fine lines myriads of drops from the autumnal hoar-frost produced exquisitely coloured concentric rings, the result of diffraction and interference of the declining solar rays.

In concluding this notice I may chronicle a curious observation made upon the effect of *steam*, when intercepting the view of a lunar corona. I was in a train near the engine from which the steam burst in large volumes right across the *double* corona which I had been watching in the bright moonlight. Every time the steam intervened it cut off completely in a moment the outer ring which again burst into view the moment the steam was dissipated. The large inner disc remained entirely unaffected, being seen as plainly through the steam as before, so that the corona was alternately single and double. It is understood that the *size* of these rings is related to that of the drops or vesicles, and that where their magnitude greatly varies, the overlapping and interference originate, not concentric rings, but a disc only, or "luminous aureola."

[It seems a pity that the term "corona" should be used in the above connection. "Corona" has so definite and special a significance, that to apply it, not only to the outer appendages of the sun, but also to phenomena quite unlike it, and due entirely to influences within our own atmosphere, is distinctly to be deprecated.—E. Walter Maunder.]

* This small disc was seen several times of a pale green colour during the drought, 1898.

† The size of this disc is contracted in the sketch.

MAMMOTH IVORY.

By R. Lydekker.

IN spite of all their ingenuity and skill, there are two animal products of high commercial value which our manufacturers have not hitherto imitated with such success as to make the substitutes equivalent in utility and beauty to the originals. These products are elephant ivory and whalebone, and although the imitations in the former case make a much nearer approach to the true article than has been found practicable in the latter, they still leave much to be desired. Consequently, the demand for natural ivory is not only likely to be maintained on the same level as heretofore, but would undoubtedly increase if an adequate supply were forthcoming.

True ivory, to which the name should properly be restricted, is the constituent of the tusks of elephants of different species, and is found in no other animals. In making this statement it must not be assumed that its presence in mastodons is denied, since those extinct animals are nothing more than elephants in a wider sense of the term. From other so-called ivory, such as that of hippopotamus tusks, sperm-whale teeth, and narwhal "horns," elephant ivory is readily distinguished at a glance by the "engine-turned" pattern—similar to that on the back of a watch case—which it displays in cross-section, as may be seen by looking at the butt-end of the handle of a table knife. And it is probably due to this peculiarity of internal structure that elephant ivory displays the elasticity which forms one of its most valuable properties.

As all the readers of this journal are doubtless aware, there are only two living species of elephants at the present day, namely the Indian, or, as it might with more propriety be called, Asiatic, and the African. As regards the production of ivory, the latter is, or, perhaps, was, much the more valuable animal of the two. In the first place, till within the last few years, it existed in almost incredible numbers in many parts of its habitat; and in the second place, it produced more ivory, animal for animal, this being due to the circumstance that whereas in the African species both sexes are furnished with tusks of large size, in its Asiatic cousin they are generally restricted to the male

XUM

sex, and even then in certain cases may be but very poorly developed.

Again, it appears that in modern times, at all events, much of the ivory yielded by the Asiatic elephant is worked up in the land of its birth, comparatively little reaching Europe in the raw state. Consequently, for recent ivory, the European market is very largely dependent upon the product of the African species, for which the great commercial emporia are London and Antwerp. Now, although, a few years ago, elephant hunting was a profitable trade in the remoter districts of south-east Africa, the herds have been so reduced in number, that comparatively little ivory is obtained at the present day. Moreover, the great stocks of ivory formerly possessed by the native chiefs have been largely reduced or exhausted over the greater portion of the country. It is true, indeed, that in the Congo district elephants are still locally abundant, while the opening up of the Egyptian Sudan may very probably introduce to the market a supply of tusks from Kordofan, Dafur, and the Bahr-el-Gazal districts. But if these regions prove productive in ivory, it is only too likely, unless proper precautions are taken, that they will comparatively soon be shot out. And if the production be not placed under restriction it is evident that the annual supply will be relatively small.

It is clear, therefore, that African ivory is likely to become gradually scarcer and scarcer; and if there were no other source of supply this beautiful substance would apparently soon reach a prohibitive price.

As a matter of fact there exists, however, in the frozen tundras of Siberia a supply of ivory which will probably suffice for the world's consumption for many years to come.

This ivory is the product of the mammoth (*Elephas primigenius*), a species nearly allied to the Indian elephant, but protected from the cold of the Arctic regions by a coat of long, coarse hair, with a finer woolly underfur at the base. The tusks, too, of the mammoth, were larger and more curved than those of its living Asiatic relative, being sometimes twisted into a spiral almost recalling that formed by the horns of the African kudu. From the abundance of these tusks it is further probable that they were developed in both sexes.

In addition to dwelling on the Arctic tundras of the Lena, Yenisei, and Obi Valleys, as well as extending to the New Siberian Islands (which in past times evidently formed a portion of the Asiatic mainland), and Alaska, the mammoth roamed over a large portion of Europe in Pleistocene times. And in the gravels and brick-earths of our English river-valleys its tusks, teeth, and bones are of comparatively common occurrence; while quantities of similar remains are dredged from the Dogger-bank by the North Sea trawlers. If, however, the ivory-turner expected to find a workable commodity in British mammoth tusks he would be grievously disappointed. All those found in the gravels and brick-earths, as well as the specimens hauled up from the Dogger-bank, have lost the greater part of their animal matter, in consequence of which they crumble more or less completely to pieces when exposed to the influence of the atmosphere, and for the purpose of preservation and exhibition have to be copiously treated with size or gelatine.

Not so the mammoth ivory of the Siberian tundras, which, in the best preserved specimens, retains the whole of the original animal matter, and, except when stained by earthy infiltrations, is as suitable for the purposes of the turner as the best product of the African elephant. This remarkable state of preservation has been produced by entombment in the frozen soil of the tundras. In many instances, as is well known, entire carcases of the mammoth have been found thus buried, with the hair, skin, and flesh as fresh as in frozen New Zealand sheep in the hold of a steamer. And sleigh-dogs, as well as Yakuts themselves, have often made a hearty meal on mammoth flesh thousands of years old. In instances like these it is evident that the mammoths must have been buried and frozen almost immediately after death, but as the majority of the tusks appear to be met with in an isolated condition, often heaped one atop of another, it would seem that the carcasses were often broken up by being carried down the rivers before their final entombment. Even then, however, the burial, or at least the freezing, must have taken place comparatively quickly, as exposure in their ordinary condition would speedily deteriorate the quality of the ivory.

The retention of their animal matter and their unaltered condition have led some writers to object to the application of the term fossil to the Siberian mammoth tusks, and to restrict its use to the altered and partially petrified specimens met in the superficial deposits of warmer countries. This, however, is quite illogical, seeing that a fossil must be defined as including the remains or traces of any animal or vegetable buried in the earth by natural causes. And we may, therefore, with perfect propriety speak of the Siberian mammoth tusks as fossil, in contra-distinction to petrified, ivory.

How the mammoths were enabled to exist in a region where their remains became so speedily frozen, and how such vast quantities of these became accumulated in certain spots, are questions which do not at present seem capable of being satisfactorily answered; and their discussion would accordingly be useless, not to say out of place, on the present occasion. It will suffice to say that such accumulations do exist, and that the soil of certain portions of the tundras seems to be almost crammed with such remains.

It may, however, be remarked that the contents of the stomachs of the frozen mammoths, as also those of the two species of rhinoceroses which were their fellow inhabitants of the tundras, contain remains of pine needles and other vegetable substances. And from this it may be inferred that the tundras themselves were clothed with forest during the mammoth epoch; since the theory that the carcases were carried down by the rivers flowing from warmer southern regions into the Arctic Ocean can scarcely merit serious attention. Possibly some light may be thrown upon the subject by the great accumulations of bones of large recent mammals, which have been met with in certain districts of East Africa.

Although, outside scientific and commercial circles comparatively little is known with regard to the subject in England, mammoth ivory, in place of being a modern discovery, was known to the ancients, and has for centuries been an article of trade and manufacture. It is, however, only recently that the history of the subject has been worked out; and for this we are largely indebted to the labours of Sir H. H. Howorth,* and Dr. Trouessart,† of Paris. Baron Nordenskiöld has likewise contributed important information on the subject in the "Voyage of the Vega." And it is from these sources that the following paragraphs are mainly compiled.

If we may take the "buried ivory" mentioned by Pliny on the authority of Theophrastus, a disciple of Aristotle, to be the same as mammoth ivory, we may regard this substance as known to the western world in the time of Alexander. But apart from this, mammoth ivory was evidently familiar at a very remote time to the Chinese,

* "The Mammoth and the Flood," Chap. III. (1887.)

† "Le Mammoth et l'Ivroire de Sibérie," *Bull. Soc. Acclim. Paris*, 1898.

who spoke of the animal by which it was yielded as "thien-shu," the mouse that hides. This mythical creature, which was compared in size to an elephant, was reported to lead a subterranean existence like a mole, with bones as white as ivory, and the flesh cold, but pure and wholesome. This reference to the coldness of the flesh apparently pointing to their acquaintance with frozen mammoth carcases.

In Europe, Eginhard, the historian of Charlemagne, states that among the presents sent to the Emperor of the West by the Kalif Haroun-al-Raschid in the year 807 were the horn of a "licorne" and the claw of a griffon. These rarities were long preserved in the royal treasury at St. Denis; and, from a description given in a work dated 1646, it appears that while the former was a mammoth tusk, the latter was the horn of the woolly Siberian rhinoceros.

During the ninth or tenth century* Arab traders appear to have established a trade-route from Northern Russia or Siberia to Persia or Syria; and their records refer to the occurrence of buried ivory near the city of Bolghari, on the Volga, which was probably situated on or near the site of the modern Nijni-Novogorod. The first Siberian mammoth tusk imported into Western Europe in modern times was brought to London in the year 1611 by one Josias Logan, by whom it had been purchased from the Samoyedes of the Pechora district. Concerning this specimen, Baron Nordenskiöld writes that as Englishmen at that time visited Moscow frequently, and for long periods, a remark occurring in Purchas's history appears to indicate that fossil ivory first became known in the capital of Russia sometime after the conquest of Siberia.

Be this as it may, it is in evidence from the account of Avril, who travelled in Russia during 1685, that fossil ivory was at that time imported into China and other Asiatic countries, where it was highly esteemed; and it is stated that it was largely employed by Turks and Persians for ornamenting sword and dagger hilts, being preferred to Indian ivory on account of its whiter colour and finer grain. And here it may be incidentally mentioned that, according to the same author, the Russian term *mammout* is a corruption of the Hebrew *behemot*, or *behemoth*, which the Arabs make *mehemot*. Canon Tristram is, however, of opinion that in the Bible behemoth often refers to the hippopotamus; and, if this be correct, a transference of the name would appear to have been made by the Arabs, this being the less improbable since it is stated in Hebrew to be applicable to any large beast.

Apart from this there is a record that about 1722 Peter the Great ordered the collection of tusks and other remains of the mammoth for the museum at St. Petersburg. And between 1750 and 1770 a Russian trader, named Liakhoff, established an extensive importation of mammoth ivory from the districts lying between the Khotanga and Anadyr rivers, and likewise from one of the southernmost islands of the New Siberian group, which still bears his own name. Surveys subsequently made by the Government in those islands indicated that the soil is teeming with the bones, tusks, and teeth of mammoths; while the adjacent mud-banks exposed at low tide are equally prolific. Some idea of their abundance may be gathered from the account given by Dr. Bunge, who visited Liakhoff Island from 1882 to 1884, and in the course of three short summers collected no less than two thousand five hundred selected specimens. In the New Siberian Islands the thermometer now often falls to fifty degrees Centigrade below freezing point, so that collecting is an impossibility during the winter.

* Dr. Trouessart gives the former, and Sir H. Howorth the latter.

With regard to the amount of mammoth ivory that comes into the market, accounts are by no means so numerous nor so accurate as might be desired. It is stated, however, that in 1821 a Yakut brought back five hundred puds (forty pounds to the pud) from the New Siberian Islands; and between the years 1825 and 1831 the amount annually sold in Yakutsk ranged between one thousand five hundred and two thousand pud, in addition to that disposed of at other towns. Many writers speak of seeing boat-loads of tusks on the Lena and Yenisei—a steamer which carried Baron Nordenskiöld in 1875 having a cargo of over one hundred. About the year 1840, Dr. Middendorff, who visited the country, estimated that the annual output of Siberian ivory reached one hundred and ten thousand pounds, representing at least a hundred individual mammoths; so that the total number of animals whose remains have been exported since the conquest of Siberia must be between twenty thousand and thirty thousand. And since Middendorff's estimate probably errs on the side of being too low, the numbers may have been considerably in excess of this.

In the London market, according to Mr. Westendarp, one thousand six hundred and thirty fine mammoth tusks were sold during the year 1872, and one thousand one hundred and forty in the following year; the weight of these varying from one hundred and forty to one hundred and sixty pounds each. Only a small percentage of these were, however, fit for the turner of ivory of high quality; about fourteen per cent. being of the best description, seventeen per cent. of inferior quality but still useful, while fifty-four per cent. were bad, and the remaining fifteen per cent. rotten and worthless.

According to Dr. Trouessart the price of mammoth ivory in the market at Yakutsk is twenty-five francs per pud for the highest quality, seventeen and a half francs for the second, and from five to seven francs for the third quality. A small quantity is worked up locally into ornamental and fancy articles of various kinds; but this industry seems to be a waning one, and more and more of the raw material goes direct to the foreign market. Yakutsk, which is situated on the Lena about midway between its mouth and the frontier of China, and has about five thousand inhabitants, has long been the acknowledged centre of the trade; but it is considered probable that at present the great bulk of the ivory goes to China, and that only a comparatively small portion finds its way into the more distant markets of Europe. The opening up of the country by the Siberian railway may, however, lead to a revolution in this respect, and also inaugurate a new era of prosperity for Yakutsk and the other Siberian towns.

With regard to the future development of the trade and the persistence of the supply, it may be remarked that only a small portion of Siberia has hitherto been explored at all, and that other deposits remain to be discovered. Of those already worked, Dr. Trouessart writes as follows:—

"It is difficult to believe that the enormous quantity of tusks indicated by the masses of bones spoken of by travellers who have visited the archipelagos of Northern Siberia can have been accumulated in the course of only a few centuries. It is most probable that only the surface of these vast bone deposits has hitherto been exploited, and that by excavating the soil to a greater depth, and, if necessary, employing the aid of dynamite to break up the frozen strata, good results will be obtained.

"If this idea be well founded, and if, as is unfortunately only too probable, the supply of African ivory comes practically to an end at no very distant date, there is every hope of finding a precious reserve in the fossil ivory of Siberia."

XUM

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

A tough cement, suitable for use with the thinnest of rock-sections, may be made by heating together for some time sixteen parts by weight of Canada balsam and fifty parts of shellac.

Distilled water should be used in the treatment of microscopic objects on all occasions, as, on the evaporation of ordinary water, crystalline salts may be deposited on the object.

To remove an excess of balsam from around a cover-glass, allow the balsam to become hard and then chip it away with the edge of a blunt knife, taking care to avoid touching the cover-glass during the operation. A tooth brush dipped in methylated spirits will then readily remove what is left. Finally, dry and polish the slide with Japanese filter paper.

Specimens of plasmodia, for the study of the myxomycetes, may be obtained from the sclerotia which is to be found attached to rotten wood or on the ground beneath old logs. To prepare these, Mr. M. Barber, of Kansas University, suggests that pieces of the material should be placed in a warm moist place. After a few hours the plasmodia will develop, and they may then be fed with rotten wood or fleshy fungi. Small plasmodia, for the demonstration of protoplasmic currents, may be obtained by putting pieces of sclerotia in a hanging drop of water, or by placing in a large cover-glass on a plasmodium and transferring it to a moist cell after the plasmodium has run over it.

Kleinberg's picro-sulphuric acid is recommended for fixing zoophytes and polyzoa with their tentacles extended. The specimens should be placed in water, and as soon as they extend themselves they should quickly be covered with the solution. Fixation follows rapidly, when, after immersion in the usual grades of alcohol, they may be stained with any ordinary stain. Picro-carmine gives the most satisfactory results.

Formalin is now largely used in most laboratories as a preservative and fixative re-agent. It does not interfere with the processes of staining to any appreciable extent, nor does it cause much shrinkage of the structures operated on. Both as regards ease of manipulation and expense, it is decidedly superior to osmic acid.

A novel method of illumination, for the investigation of the structure of diatoms, is suggested by Mr. Allan Dick in his "Notes on the Polarizing Microscope." A thin platinum wire is twisted into a loop of just sufficient size to allow of the passage of a darning needle. This wire is rendered incandescent by a spirit lamp or a Bunsen burner, and it is placed at a distance of eight inches from a condenser in such a manner that the loop may be at right angles to the axis of the microscope tube. The most favourable condition for using this source of illumination is when the image of the loop may be seen in the field of view just surrounding the object. In some cases it is better to use a triangular rather than a circular loop, so as to minimize the risk of mistaking circular effects.

To preserve for an indefinite period such fluid mounts as fish embryos, ova, and the like, it is necessary to use a cement having exceptional strength and fluid-resisting properties. The following cement is admirably adapted for this purpose. Take two parts of carbonate of lead, two parts of red oxide of lead, and three parts of litharge. Grind these very finely, mix them dry and keep in a wide-mouthed bottle. When required for use a little of the powder should be mixed with old gold size on a watch glass. It is necessary that there should be no trace of grit or unground matter in the mixture. A cell made with this cement may be filed off the glass slip without the cell breaking away.

In a paper recently read before the Manchester Microscopical Society, Mr. J. V. Wolstenholme, F.R.M.S., gives details of the methods that were employed in his investigations on the micrococci (Botriomyces), which produce tumours in domesticated animals. He removed from the groin of a horse a pear-shaped tumour, the mass of which was dense, firm, and resistant, and of a pale pink colour. In the centre was an abscess cavity, two and a half by one and a half inches, which communicated by narrow channels with a large sore or ulcer at the base of the tumour. For microscopical examination, portions of this tumour were hardened in (α) Müller's fluid, (β) picric acid, (γ) alcohol, after which they were easily cut with the freezing microtome, and stained readily. In some cases it was found to be an advantage to embed the portion of tissue in celloidin before cutting. The stains used were (α) picro-carmine, (β) hæmatin followed by picro-carmine, (γ) hæmatin, and then rubin and orange combined, (δ) the Plantz method. Of these, the hæmatin with rubin and orange gave the most perfect differentiation. The fibrous tissue was thus stained pink, and the nuclei purple. It was in the nuclei, which appeared as minute specks in a delicate fibrous growth, that the colonies appeared. Under the one-sixth objective a colony was seen to be made up of grape-like bodies, some of a pale orange, and others of a pale green colour, but under the one-twelfth inch oil immersion the grape-like bodies were seen to be filled with cocci—small round elements—which were about 3 μ diameter.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Chase's Comet.—This comet, which is remarkable as having been discovered by photography in the position of the radiant point of the Leonids on the very night when a shower of these meteors was expected, is receding from the earth and becoming perceptibly fainter. On March 4th its apparent brightness will be 0·75, or three-fourths the amount it exhibited at the time of discovery. The comet is moving slowly westwards in the region between Leo Minor and the southern limits of Ursa Major, and its position on March 4th will be R.A. 10h. 54m. 31·4s., Dec. + 38° 10′ 40″. It will be distant from the earth about one hundred and ninety millions of miles. The latest computations of the orbit show that the observations are satisfied by parabolic elements, and that there is no probability that the comet is identical with Comet 1867 I., as has been suggested.

Wolf's Comet.—This object remains faintly visible in large instruments, and is situated in the south-west part of Monoceros. On March 4th it will be separated from the earth by an interval of two hundred and seven millions of miles, and its apparent place will be R.A. 6h. 19m. 24s., Dec. −8° 8′. The comet is moving slowly to the N.E., and is not likely to be visible much longer even in the best telescopes.

The Recent Shower of Leonids.—Reports of this display continue to come in, and show the very widespread interest manifested in the phenomenon. That this interest will be further accentuated next November is certain, seeing that the outlook is more promising as regards a really fine display. The moon, it is true, will be nearly full, and must, in any case, rob the event of much of the imposing effect it would have presented on a dark sky; but if the shower returns in its full strength it will, even in the presence of unfavourable circumstances, prove a striking spectacle. Many of the Leonids are bright meteors, quite equal to first magnitude stars, and will be distinctly visible in moonlight. The observations in 1898 have been of decided value in several connections. The photographs. taken in combination with the naked eye observations, prove that the radiant is in about R.A. 151°, Dec. 22·3°. The results also prove that the earth did not really encounter the main body of meteors, but only a tenuous region of the stream far in the van of the parent comet. The estimates of the time of maximum seem to have differed at various places, as though locality affected the visible numbers in some degree. In the case of a comparatively feeble shower such discordances are sure to occur, as the methods of observers, the number employed, the suitability of their positions, and other circumstances affect the results. In any case, the recent shower of Leonids was certainly most numerously presented after sunrise in England, so that even had favourable weather backed up the efforts of observers in this country, the phenomenon would have been one of decidedly minor importance.

Meteors and the Spring Season.—Very few meteors are usually observed in the spring season; in fact, as regards these objects, it may be considered as the most unproductive time of the year. Fireballs, however, occasionally appear, and provide valuable materials for discussion. On January 26th a very fine meteor was seen at 8h. 56m. p.m., by Mr. Sheppard at Bishop

Stortford, Herts, travelling from centrally between the two stars in the tail of Ursa Major towards ι Draconis. This object was also seen by Mr. A. King at Leicester, and he noted the path as being from 178½° +60° to 171½° + 54°, but the observation was not a very good one. On February 12th, at 8h. 45m., a large meteor was seen in a cloudy sky by Mr. T. Harries, at Llanelly, who states it fell almost vertically in azimuth 70° west of south altitude 35° to 15°. On February 13th, at 8h. 37m., Mr. H. Corder, at Bridgwater, noted a slow-moving second magnitude meteor, travelling from *f* Tauri eastwards from the direction of α Arietis. Meteors of the latter type are interesting from the fact that their radiants lie in the western sky.

THE FACE OF THE SKY FOR MARCH.

By A. FOWLER, F.R.A.S.

THE SUN.—On the **1st** the Sun rises at 6.48, and sets at 5.38; on the **31st** he rises at 5.39, and sets at 6.29. The Sun enters Aries, and Spring commences on the **20th** at 8 P.M. A well marked decline in the number and size of sunspots has lately been noted.

The zodiacal light may be looked for in the west during two or three hours after sunset.

THE MOON.—The Moon will enter her last quarter on the **5th**, at 4.7 A.M.; will be new on the **11th**, at 7.53 P.M.; enter her first quarter on the **19th**, at 3.24 A.M.; and will be full on the **27th**, at 6.19 A.M. Occultations of 56 and 61 Geminorum (mags. 5·0 and 5·7) will occur on the **20th**. The disappearance of the former takes place before sunset, at 5.32 P.M., at an angle of 124° from the north point (152° from vertex), and the reappearance at 6.50 P.M., 265° from the north point (275° from the vertex). 61 Geminorum disappears at 8.50 P.M., at 83° from the north point (60° from the vertex); and reappears at 9.59 P.M., 320° from the north point (286° from the vertex).

THE PLANETS.—Mercury is an evening star throughout the month, and will be favourably situated in the west for observation, after sunset, for some days before and after the **24th**, when he will be at his greatest easterly elongation of 18° 36′. We may note that the angular distance from the sun is small at this elongation, for the reason that the planet is near perihelion, the actual perihelion passage occurring on the **17th**, at 2 P.M. The elongation, however, is favourable, because when the sun is setting near the vernal equinox, the ecliptic is greatly inclined to the horizon. The apparent diameter of the planet on the **24th** will be 7·4″, and on that date he will set about an hour and fifty minutes after the sun. During the time of his visibility his path lies in Pisces, and there will be no bright star in his immediate neighbourhood. At 7 P.M. on the **24th** he will be about 10° above the horizon, his amplitude then being only two or three degrees north of west.

Venus remains a morning star throughout the month. Her declination ranges from 19° south to 12° south, but at the beginning of the month she rises about two hours, and at the end a little more than one hour, before the Sun. The path of the planet is a little south of the ecliptic, through the most easterly part of Sagittarius until the **10th**, then through Capricornus, crossing the ecliptic on the **27th**, and passing into Aquarius. At the middle of the month, 0·64 of the disc will be illuminated.

Mars will still be a conspicuous object in Gemini. Passing from his recent stationary point a little south-west of Pollux, he will traverse a short easterly path to a point almost in a line with Castor and Pollux. At the middle of the month he will have an apparent diameter of 9·8″, as compared with 14·4″ at the opposition, on January **18th**. On the **1st** he will be on the meridian at 8.49 P.M., and on the **31st** at 7.14 P.M., setting on these dates at 5.20 A.M. and 3.27 A.M. respectively. On the 15th, 0·922 of the disc will be illuminated.

Jupiter is rapidly coming into a position for observation at convenient hours. On the **1st** he rises about 11 P.M., and on the **31st** shortly before 9 P.M. During the month he describes a short retrograde or westerly path, not far to the west, and a little north of α Libræ. The polar diameter increases from 37·4″ to 40·2″. When on the meridian at London the planet will be about 25° above the horizon.

Saturn is a morning star, and continues his eastward path through the most southerly part of Ophiuchus. On the **1st** he rises shortly before 3 A.M., and on the **31st** a little before 1 A.M. He will be in quadrature with the Sun on the **14th**.

Uranus rises on the **1st** about 1.40 A.M., and on the **31st** about 11.40 P.M. He describes an eastward path until the **13th**, when he will be stationary, after which his path will be westerly near ω Ophiuchi. The southern declination of the planet is 21½°, and the apparent diameter 3·6″.

Neptune is stationary on the **3rd**, and in quadrature on the **12th**. He remains in the neighbourhood of ζ Tauri, preceding this star by about 6m., and lying about 50′ to the north.

THE STARS.—About the middle of the month, at 9 P.M., Aries will be nearly setting a little north of west, Taurus will be nearly due west, Orion in the south-west, Capella high up in the west, Sirius low down about 30° west of south, Procyon and Gemini higher and a little nearer the meridian, Cancer on the meridian, Leo pretty high up in the south-east, Arcturus in the east, Hercules and Vega low down in the north-east.

Minima of Algol will occur on the **4th** at 12.21 A.M., on the **6th** at 9.10 P.M., on the **26th** at 10.53 P.M., and on the **29th** at 7·41 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of February Problems.

(J. Nield.)

No. 1.

1. Q to Q3, and mates next move.

No. 2.

1. Q to Rsq, and mates next move.

CORRECT SOLUTIONS of both problems received from G. A. Forde (Capt.), K. W., Alpha, J. M. K. Lupton, G. C. (Teddington), G. Reed Makeham, C. T. Kershaw, H. H. Thomas, W. H. Stead, F. V. Louis, W. de P. Crousaz, W. Clugston, W. Hughes, D. R. Fotheringham.

Of No. 1 only, from Miss J. G. Theakston, H. S. Brandreth.

Of No. 2 only, from Sunnyside, G. G. Beazley.

[The dual in No. 1 (after K to Q4) appears to have escaped general notice; also the clever "try" by 1. Q to Bsq. F. V. Louis alone mentions them.]

G. G. Beazley and Sunnyside.—1. Q to R5 is met by B to Kt2.

H. S. Brandreth.—In No. 2, if Q to R7, P to K6.

H. Bristow.—Thanks for your problem. Is there not a second solution by 1. R to R5? From an economical

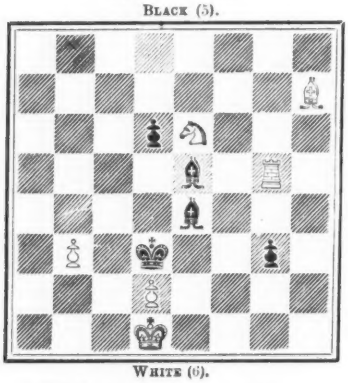
point of view this Rook is also an offender. Personally we object to the Black Queen and its attendants, which provide only one defence.

PROBLEMS.

No. 1.

By V. H. M.

BLACK (5).



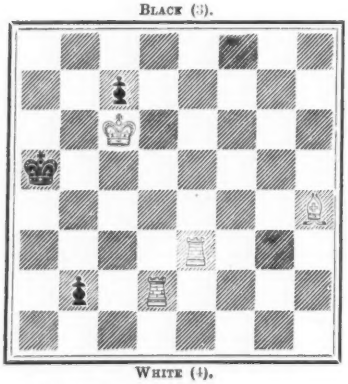
WHITE (6).

White mates in two moves.

No. 2.

By W. I. M.

BLACK (3).



WHITE (4).

White mates in two moves.

CHESS INTELLIGENCE.

Surrey has defeated Sussex, by 11½ games to 8½, in the Southern Counties Chess Union Competition. A Northern Chess Union has recently been formed, Mr. I. M. Brown being the secretary.

The correspondence match of two games between the Vienna and St. Petersburg Chess Clubs has resulted in a victory for the former club, who won one game and drew the other. The Janowski-Showalter match has also been brought to a conclusion, the final score being Janowski 7, Showalter 2, drawn 4. Since Mr. Showalter's first match against Pillsbury he has never shown any form approaching his performance in that encounter.

The brilliancy prizes in the recent Vienna Tournament have at length been awarded. Mr. Pillsbury takes the first, the two others going to Herren Lipke and Marco.

The London International Tournament is arranged to begin on May 30th. Play will take place in St. Stephen's Hall, Westminster. The principal event will be a two-round tournament, limited, probably, to sixteen players. There will also be an unlimited one-round competition. The whole tournament is expected to last six or seven weeks.

The annual match by cable between the British Isles and the United States is fixed for March 10th and 11th. The British team will play, as last year, at the Hotel Cecil, play beginning at 3 p.m. on the 10th. The following team has been selected:—Messrs. H. E. Atkins, G. E. H. Bellingham, J. H. Blackburne, A. Burn, E. M. Jackson, Herbert Jacobs, T. F. Lawrence, C. D. Locock, D. Y. Mills, and G. E. Wainwright. Reserves: H. W. Trenchard, G. Walker, and W. Ward. The American Committee are said to be making strenuous exertions to strengthen their team at the last three boards, at which the British team have hitherto scored heavily; for should their representatives fail to turn the tables this year, the cup will be held permanently by their opponents. In the British team the only player new to the match is Mr. Wainwright, who has been scoring very heavily in the level and handicap tournaments at the British Chess Club. Mr. Lawrence played in 1897, when he had the misfortune to lose. He was omitted from the 1898 team owing to his disastrous start in the City of London Championship; nevertheless, he won that tournament in spite of his disastrous start, and as he has the best score again this year, he could hardly be left out of any representative team. It must have been an invidious task to decide on the two members of the 1898 team to be left out; the choice ultimately fell on Mr. H. Caro, who lost at board No. 3, and Mr. Trenchard, who won at board No. 10.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 159 (January).

The Mycetozoa, and some Questions which they Suggest. By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry. (*Illustrated.*)

Ozone and its Uses.

Two Months on the Guadalquiver.—I. The River. By Harry F. Witherby. (*Illustrated.*)

Witt's Planet DQ.

Considerations on the Planet Saturn. By E. M. Antoniadi. (*Illustrated.*)

Science Notes.

British Ornithological Notes.

Notices of Books.

Letters.

The Ovipositor of a Beetle (*Baptolanus alternatus*) and the Teeth of the Dung Fly. By Walter Wesché. (*Illustrated.*)

Electricity as an Exact Science. By Howard B. Little.

Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.

Microscopy. By John H. Cooke, F.L.S., F.G.S.

The Face of the Sky for January. By A. Fowler, F.R.A.S.

Chess Column. By C. D. Locock, B.A.

PLATE.—Saturn.

Contents of No. 160 (February).

On the Treatment and Utilization of Anthropological Data.—I. Colour. By Arthur Thomson, M.A., M.D. (*Illustrated.*)

The Bad Language of Wild Birds. By Charles A. Witchell.

The Karkinokosm, or World of Crustacea.—VII. The Box Crustacea. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S. (*Illustrated.*)

Secrets of the Earth's Crust.—I. The Unseen Core. By Grenville A. J. Cole, M.R.I.A., F.G.S. (*Illustrated.*)

Notices of Books.

Science Notes.

Obituary.

Letters.

The November Meteors in 1898.

Photograph of the Nebula N. G. C. No. 1499 Persei. By Isaac Roberts, D.SC., F.R.S. (*Plate.*)

Comparative Photographic Spectra of the Brighter Stars.

British Ornithological Notes. Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

The Nervous System of our Empire. By John Mills.

The Icknield Way in Norfolk and Suffolk. By W. G. Clarke. (*Illustrated.*)

Microscopy. By John H. Cooke, F.L.S., F.G.S.

Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.

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